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(71)Applicant : NSK LTD
(72)Inventor : HAGIWARA NOBUYUKI
HORIIE AKIFUMI

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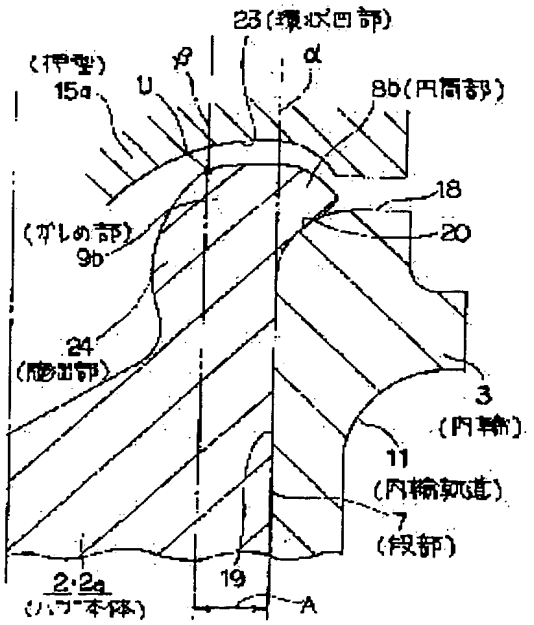
## (54) METHOD OF MANUFACTURING HUB UNIT FOR SUPPORTING WHEEL AND MANUFACTURING DIE THEREFOR

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent occurrence of cracks in a calking part 9b and reduction in the rolling fatigue service life of an inner race raceway track 11, accompanying machining of the calking part 9b for pressing down an inner race 3 to hub bodies 2 and 2a.
SOLUTION: Average stress of compression for the calking part 9b is applied continuously during the machining by devising the shape of a cylindrical part 8b to be formed as the calking part 9b, by the cross-sectional shape of an annular recessed part 23 of a die 15a for plastically deforming this cylindrical part 8b.

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CLAIMS

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[Claim(s)]
[Claim 1] The hub body in which the flange for supporting a wheel to an end section peripheral face was formed, The first inner-ring-of-spiral-wound-gasket orbit formed in the pars intermedia peripheral face of this hub body through the inner ring of spiral wound gasket of another object with this direct or hub body, The step to which the outer-diameter dimension became small rather than the part in which this first inner-ring-of-spiral-wound-gasket orbit formed in the other end of the above-mentioned hub body was formed, The outer ring of spiral wound gasket in which the second outer-ring-of-spiral-wound-gasket orbit which counters the inner ring of spiral wound gasket which formed the second inner-ring-of-spiral-wound-gasket orbit in the peripheral face, and was attached outside the above-mentioned step, the first outer-ring-of-spiral-wound-gasket orbit which counters the inner-ring-of-spiral-wound-gasket orbit of the above first at inner skin, and the inner-ring-of-spiral-wound-gasket orbit of the above second was formed, It has the rolling element prepared every, respectively between the second inner-ring-of-spiral-wound-gasket orbit and the above-mentioned first and second outer-ring-of-spiral-wound-gasket orbit for a start [ above-mentioned ]. [ two or more ] By the caulking section which formed the body formed in the part projected rather than the inner ring of spiral wound gasket attached outside the above-mentioned step at least by the other end of the above-mentioned hub body by carrying out plastic deformation to the method of the outside of the diameter direction In order to build the hub unit for wheel support which carried out joint immobilization of the inner ring of spiral wound gasket which turns to the level difference side of this step the inner ring of spiral wound gasket attached outside the above-mentioned step, stopped it, and was attached outside this step at the above-mentioned hub body, With the condition of having dashed the force plunger against the apical surface of this body in the manufacture approach of the hub unit for wheel support which is made carrying out plastic deformation of the above-mentioned body, and is made into the above-mentioned caulking section, By carrying out plastic deformation of the point of this body to the method of the outside of the direction of a path, and considering as the above-mentioned caulking section, giving the force suitable for the force of shaft orientations, and the method of the outside of the direction of a path to this body from this force plunger, and compressing this body into shaft orientations The manufacture approach of the hub unit for wheel support characterized by continuing generating the mean stress of compression into the inner skin part of the above-

mentioned body throughout processing of this caulking section.
[Claim 2] The hub body in which the flange for supporting a wheel to an end section peripheral face was formed, The first inner-ring-of-spiral-wound-gasket orbit formed in the pars intermedia peripheral face of this hub body through the inner ring of spiral wound gasket of another object with this direct or hub body, The step to which the outer-diameter dimension became small rather than the part in which this first inner-ring-of-spiral-wound-gasket orbit formed in the other end of the above-mentioned hub body was formed, The outer ring of spiral wound gasket in which the second outer-ring-of-spiral-wound-gasket orbit which counters the inner ring of spiral wound gasket which formed the second inner-ring-of-spiral-wound-gasket orbit in the peripheral face, and was attached outside the above-mentioned step, the first outer-ring-of-spiral-wound-gasket orbit which counters the inner-ring-of-spiral-wound-gasket orbit of the above first at inner skin, and the inner-ring-of-spiral-wound-gasket orbit of the above second was formed, It has the rolling element prepared every, respectively between the second inner-ring-of-spiral-wound-gasket orbit and the above-mentioned first and second outer-ring-of-spiral-wound-gasket orbit for a start [ above-mentioned ]. [ two or more ] By the caulking section which formed the body formed in the part projected rather than the inner ring of spiral wound gasket attached outside the above-mentioned step at least by the other end of the above-mentioned hub body by carrying out plastic deformation to the method of the outside of the diameter direction In order to build the hub unit for wheel support which carried out joint immobilization of the inner ring of spiral wound gasket which turns to the level difference side of this step the inner ring of spiral wound gasket attached outside the above-mentioned step, stopped it, and was attached outside this step at the above-mentioned hub body, With the condition of having dashed the force plunger against the apical surface of this body in the manufacture approach of the hub unit for wheel support which is made carrying out plastic deformation of the above-mentioned body, and is made into the above-mentioned caulking section, The force suitable for the force of shaft orientations and the method of the outside of the direction of a path is given to this body from this force plunger. It follows on carrying out plastic deformation of the point of this body to the method of the outside of the direction of a path, and forming the above-mentioned caulking section, compressing this body into shaft orientations. The manufacture approach of the hub unit for wheel support which is made to move some metallic materials which constitute this body to the method of the inside of the direction of a path, and is characterized by forming the bulge section which swelled to the method of the inside of the direction of a path at the bore part of this caulking section after the completion of formation of the above-mentioned caulking section.
[Claim 3] In case the manufacture approach of the hub unit for wheel support indicated to claim 2 is enforced It is the force plunger for manufacture of the hub unit for wheel support which gives the force which dashed against the apical surface of a body and turned to the force of shaft orientations, and the method of the outside of the direction of a path at this body. It pushes in inside the above-mentioned body formed in the apical surface center section. The heights of the shape of a free truncated cone, It has the annular crevice formed in the perimeter of these heights in the condition of surrounding the perimeter of these heights. The cross-section configuration of this annular crevice The bore side radii section which exists in a bore approach part, and the outer-diameter side radii section which exists in an outer-diameter approach part and has radius of curvature smaller than this bore side radii section In the condition of having considered as the posture in which make it continue smoothly through direct or a bay, and the above-mentioned annular crevice is compared to the apical surface of the above-mentioned body, the core of the radius of curvature of the above-mentioned bore side radii section Outside rather than the core of the radius of curvature of the above-mentioned outer-diameter side radii section, it does not exist about the diameter direction of the above-mentioned body. And the core of the radius of curvature of the above-mentioned outer-diameter side radii section The force plunger for manufacture of the hub unit for wheel support characterized by not existing outside about the direction of a path of this body rather than the peripheral face of the above-mentioned body.

[Translation done.]

* NOTICES *



## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] The manufacture approach and the force plunger for manufacture of the hub unit for wheel support concerning this invention are used in order to build the hub unit for wheel support for supporting the wheel of an automobile free [ rotation ] to a suspension system.
[0002]
[Description of the Prior Art] The wheel of an automobile is supported to a suspension system by the hub unit for wheel support. Drawing 10 shows one example of the hub unit for wheel support indicated by the U.S. Pat. No. 5490732 specification. This hub unit 1 for wheel support is equipped with the hub body 2, one pair of inner rings of spiral wound gasket 3a and 3b, an outer ring of spiral wound gasket 4, and two or more rolling elements 5 and 5. The heel of the peripheral face of the hub body 2 of these (outside means the side which serves as approach outside the cross direction in the state of attachment by the automobile, and serves as left-hand side of drawing 10 .) the side which serves as crosswise central approach on the contrary is called inside, and it becomes the right-hand side of drawing 1010 . **** -- the flange 6 for supporting a wheel is formed. Moreover, the step 7 is formed in the central approach part of the above-mentioned hub body 2 in the end face section of this flange 6.
[0003] The one above-mentioned pair of inner rings of spiral wound gasket 3a and 3b were attached outside the part from the pars intermedia of the above-mentioned hub body 2 to a toe, among these the outer edge surface of outside inner-ring-of-spiral-wound-gasket 3a is dashed against the level difference side of the above-mentioned step 7, and they have dashed the outer edge surface of inside inner-ring-of-spiral-wound-gasket 3b against the inner end face of inner-ring-of-spiral-wound-gasket 3a of the above-mentioned outside, respectively. In addition, when it sees from inside inner-ring-of-spiral-wound-gasket 3b, the inner end face of outside inner-ring-of-spiral-wound-gasket 3a turns into a level difference side of a step. Moreover, a body 8 is formed in the toe of the above-mentioned hub body 2, plastic deformation of the part projected to the inner direction in the point half section of this body 8 rather than the inner end face of inner-ring-of-spiral-wound-gasket 3b of the above-mentioned inside is carried out to the method of the outside of the diameter direction, and the caulking section 9 is formed. And the one above-mentioned pair of inner rings of spiral wound gasket 3a and 3b are pinched between the level difference sides of this caulking section 9 and the above-mentioned step 7.
[0004] Moreover, between one pair of outer-ring-of-spiral-wound-gasket orbits (the first and the second) 10 and 10 prepared in the inner skin of the above-mentioned outer ring of spiral wound gasket 4, and the inner-ring-of-spiral-wound-gasket orbits (the first and the second) 11 and 11 prepared in the peripheral face of each above-mentioned inner rings of spiral wound gasket 3a and 3b, two or more above-mentioned rolling elements 5 and 5 are formed every, respectively. In addition, in the example of illustration, although the ball is used as rolling

elements 5 and 5, in the case of the hub unit for wheel support for the automobiles by which weight increases, a taper roller may be used as these rolling elements. Moreover, the inner-ring-of-spiral-wound-gasket orbit (the first) 11 of flange 6 approach may be directly formed in the peripheral face of the above-mentioned hub body 2, and may omit outside inner-ring-of-spiral-wound-gasket 3a. In this case, the above-mentioned step 7 is formed in the location which is equivalent to a way among inner-ring-of-spiral-wound-gasket 3a of the outside shown in drawing 10 .

[0005] In order to attach the above hub units 1 for wheel support to an automobile, by the attachment section 12 of the shape of an extroversion flange formed in the peripheral face of the above-mentioned outer ring of spiral wound gasket 4, this outer ring of spiral wound gasket 4 is fixed to a suspension system, and a wheel is fixed to the above-mentioned flange 6. Consequently, this wheel can be supported free [ rotation ] to a suspension system.

[0006] Furthermore, while making damage on a crack (crack) etc. hard to generate in the caulking section at the time of immobilization of an inner ring of spiral wound gasket, the structure which the diameter of the inner-ring-of-spiral-wound-gasket orbit formed in the bore of the above-mentioned inner ring of spiral wound gasket or the peripheral face of this inner ring of spiral wound gasket with the caulking attachment activity makes it hard to change is indicated by JP,10-272903,A. Drawing 11 -15 show the 2nd example and its manufacture approach of structure conventionally which was indicated by the above-mentioned official report.

[0007] The thickness of body 8a for constituting caulking section 9a which was formed in the toe of the hub body 2 and which fixes an inner ring of spiral wound gasket 3 is in the condition shown in drawing 14 before closing and extending this body 8a to the method of the outside of the diameter direction, and is so small that it goes to a tip edge. For this reason, the taper hole 13 with which a bore becomes small gradually is formed in the inner end face of the above-mentioned hub body 2, so that it goes to an inner.

[0008] That the above-mentioned inner ring of spiral wound gasket 3 should be fixed to the toe of the above-mentioned hub body 2, in order to close and extend the point of the above body 8a In the condition of having prevented that the above-mentioned hub body 2, with which the above-mentioned hub body 2 shifts to shaft orientations, and does not move and which stopped the peripheral face of the above-mentioned inner ring of spiral wound gasket 3 by the piece 14 of prevention, and attached this inner ring of spiral wound gasket 3 outside as shown in drawing 15 while fixing like blurs in the diameter direction As shown in this drawing, a force plunger 15 is strongly pushed to the point of the above-mentioned body 8a. It stuffs inside the above-mentioned body 8a, the heights 16 of the shape of a free truncated cone are formed in the apical surface (lower limit side of drawing 15 ) center section of this force plunger 15, and the cross-section radii-like crevice 17 is formed in the perimeter of these heights 16 in the condition of surrounding the perimeter of these heights 16.

[0009] On the other hand, the inner end face 18 which is a flat side which intersects perpendicularly to the medial axis of this inner ring of spiral wound gasket 3 is formed in the perimeter of inner edge opening of the inner ring of spiral wound gasket 3 for fixing to the inner edge (right end [ of drawing 11 ], upper limit of drawing 12 -15) section of the above-mentioned hub body 2 by the above-mentioned caulking section 9a. And the inner skin 19 of the inner circumference edge of this inner end face 18 and the above-mentioned inner ring of spiral wound gasket 3 which is a cylinder side is made to continue by the chamfer 20 which is a cross-section radii-like curved surface.

[0010] The above-mentioned caulking section 9a for holding down the above-mentioned inner ring of spiral wound gasket 3 which made the configuration of a toe above to the step 7 of the above-mentioned hub body 2 is constituted by closing and extending the above-mentioned body 8a to the method of the outside of the diameter direction, and to the thickness a0 ( drawing 12 ) of the end face section of the above-mentioned body 8a, the thickness is dwindled as it goes at a tip. That is, as shown in drawing 13 , it is the thickness of the end face section of the above-mentioned caulking section 9a a0 The thickness of this caulking section 9a is a0, a1, and a2 as it carries out and goes to a point. --- an Although it changes in order The relation of the thickness of these each part is a0 >a1 >a2 >. --- >an It is the thickness an of the tip edge of the above-

mentioned caulking section 9a so that it may become. The cross-section configuration of the said heights 16 and the crevice 17 for [ used as zero ] forming this caulking section 9a is regulated like (an > 0).

[0011] If the force plunger 15 which has such heights 16 and a crevice 17 is attached to rocking caulking equipment and this force plunger 15 is pushed against the point of the above-mentioned body 8a, the point of this body 8a can be closed and extended to the method of the outside of the diameter direction, and the above-mentioned caulking section 9a can be formed. And the above-mentioned inner ring of spiral wound gasket 3 is pinched between this caulking section 9a and the level difference side 25 of the step 7 formed in the toe of the hub body 2, and this inner ring of spiral wound gasket 3 can be fixed to the above-mentioned hub body 2. In the case of the example of illustration, the compressive force which turns to the peripheral face of this caulking section 9a at the method of the inside of the diameter direction acts from the inside of the above-mentioned crevice 17 in the culmination which forms the above-mentioned caulking section 9a by carrying out plastic deformation of the inner end face of the above-mentioned body 8a. Therefore, it can prevent that the damage on a crack etc. occurs on the periphery edge of this caulking section 9a. Moreover, the cross-section radii-like chamfer 20 is formed in the inner edge opening periphery section of the above-mentioned inner ring of spiral wound gasket 3 which the end face section peripheral face of the above-mentioned caulking section 9a contacts. Therefore, the radius of curvature of the end face section of the above-mentioned caulking section 9a does not become small, and stress also with this end face section impossible for stops being added easily.

[0012]

[Problem(s) to be Solved by the Invention] In the manufacture approach of the above conventional hub units for wheel support indicated by JP,10-272903,A, it can be prevented effectively enough that a crack occurs on the periphery edge of caulking section 9a, but a crack may occur in the apical surface thru/or inner skin of this caulking section 9a. That is, conventionally, in the case of structure, theta 21 was comparatively enlarged with about 20 degrees whenever [ tilt-angle / of the inner skin 21 of body 8a as shown in drawing 14 ], and the difference of the thickness of the end face section of this body 8a and the thickness of a point was enlarged. If plastic deformation of such body 8a is carried out with the force plunger 15 attached to rocking caulking equipment, the mean stress of **** will become easy to generate it in the apical surface thru/or inner skin of this body 8a thru/or the above-mentioned caulking section 9a. And if the value of the mean stress of this **** becomes large, a crack occurs into the part concerned, and by becoming a defective and having to stop having to discard, the excessive process which a yield falls or repairs a crack part will be needed, and it will become the cause of a cost rise anyway.

[0013] Furthermore, whenever [ tilt-angle / of the inner skin 21 of the above-mentioned body 8a ], since theta 21 is large, in connection with pressing this body 8a with the above-mentioned force plunger 15, the force which turned to the base of this body 8a at the method of the outside of the direction of a path becomes easy to be added. If the outer diameter of this body 8a spreads according to such force, the inner ring of spiral wound gasket 3 attached outside the step 7 which exists in the perimeter of this body 8a will carry out elastic deformation, the diameter of the inner-ring-of-spiral-wound-gasket orbit 11 formed in the peripheral face of this inner ring of spiral wound gasket 3 will be expanded, and it will become the cause by which the precompression of an anti-friction-bearing part changes. The manufacture approach and the force plunger for manufacture of the hub unit for wheel support of this invention are invented that the crack of caulking section 9a and generating of diameter expansion of an inner ring of spiral wound gasket 3 constituting the above causes of an endurance fall of the hub unit for wheel support should be prevented.

[0014]

[Means for Solving the Problem] The hub unit for wheel support built by the manufacture approach of the hub unit for wheel support of this invention is equipped with a hub body, the first inner-ring-of-spiral-wound-gasket orbit, a step, an inner ring of spiral wound gasket, an outer ring of spiral wound gasket, and two or more rolling elements like the hub unit for wheel support

known from the former mentioned above. The hub body of these forms the flange for supporting a wheel to an end section peripheral face. Moreover, the inner-ring-of-spiral-wound-gasket orbit of the above first is formed in the pars intermedia peripheral face of the above-mentioned hub body through the inner ring of spiral wound gasket of another object with this direct or hub body. Moreover, the outer-diameter dimension is small rather than the part which the above-mentioned step was formed in the other end of the above-mentioned hub body, and formed this first inner-ring-of-spiral-wound-gasket orbit. Moreover, the above-mentioned inner ring of spiral wound gasket forms the second inner-ring-of-spiral-wound-gasket orbit in a peripheral face, and is attached outside the above-mentioned step. Moreover, the above-mentioned outer ring of spiral wound gasket forms the second outer-ring-of-spiral-wound-gasket orbit which counters the first outer-ring-of-spiral-wound-gasket orbit which counters the inner-ring-of-spiral-wound-gasket orbit of the above first at inner skin, and the inner-ring-of-spiral-wound-gasket orbit of the above second. Furthermore, two or more each above-mentioned rolling elements are prepared every for a start [ above-mentioned ], respectively between the second inner-ring-of-spiral-wound-gasket orbit and the above-mentioned first and second outer-ring-of-spiral-wound-gasket orbit. And by the other end of the above-mentioned hub body, the inner ring of spiral wound gasket attached outside the above-mentioned step is turned to the level difference side of this step, is stopped by the caulking section which formed the body formed in the part projected rather than the inner ring of spiral wound gasket attached outside the above-mentioned step at least by carrying out plastic deformation to the method of the outside of the diameter direction, and joint immobilization of the inner ring of spiral wound gasket attached outside this step is carried out at the above-mentioned hub body. In order that the manufacture approach of the hub unit for wheel support of this invention may build the hub unit for wheel support which has the above structures, it carries out plastic deformation of the above-mentioned body, and let it be the above-mentioned caulking section.

[0015] In the manufacture approach of the hub unit for wheel support of this invention especially indicated to claim 1, the force suitable for the force of shaft orientations and the method of the outside of the direction of a path is given to this body from this force plunger with the condition of having dashed the force plunger against the apical surface of the above-mentioned body. And generating the mean stress (mean compressive stress) of compression into the inner skin part of the above-mentioned body, compressing this body into shaft orientations is continued throughout processing of this caulking section by carrying out plastic deformation of the point of this body to the method of the outside of the direction of a path, and considering as the above-mentioned caulking section. In addition, this mean compressive stress is hydrostatic stress sigmam. Things are said. moreover, the longitudinal stress to which this hydrostatic stress sigmam acts in the direction of 3 shafts (x, y, z-axis) -- sigma1, sigma2, and sigma3 ** -- it is expressed with sigmam = (sigma1+sigma2+sigma3) / 3 when it carries out. Moreover, it is p=-sigmam when hydrostatic pressure is set to p. It becomes.

[0016] Moreover, in the manufacture approach of the hub unit for wheel support indicated to claim 2, some metallic materials which constitute this body are moved to the method of the inside of the direction of a path in connection with carrying out plastic deformation of the body and forming the caulking section. And the bulge section which swelled to the method of the inside of the direction of a path is formed in the bore part of this caulking section after the completion of formation of the above-mentioned caulking section.

[0017] Moreover, one side or the both sides of processing to which surface roughness, such as processing for raising abrasion resistance, such as ceramic coating like TiN, or shot peening, is reduced is preferably given to a part for the press surface part to which plastic deformation of this body is carried out in contact with the above-mentioned body on the front face of the above-mentioned force plunger. And the abrasion resistance for the above-mentioned press surface part is raised, or coefficient of friction for this press surface part is stabilized in 0.3 or more comparatively big values.

[0018] Moreover, as a force plunger for enforcing the manufacture approach of the hub unit for wheel support indicated to above-mentioned claim 2, it pushes in inside [ which was indicated to claim 3 ] the above-mentioned body formed in the apical surface center section like, and the

thing equipped with the heights of the shape of a free truncated cone and the annular crevice formed in the condition of surrounding the perimeter of these heights around these heights is used. And the bore side radii section which exists the cross-section configuration of this annular crevice in a bore approach part, and the outer-diameter side radii section which exists in an outer-diameter approach part and has radius of curvature smaller than this bore side radii section were made to continue smoothly through direct or a bay preferably. Moreover, the core of the radius of curvature of the above-mentioned bore side radii section is not made to exist outside about the diameter direction of the above-mentioned body rather than the core of the radius of curvature of the above-mentioned outer-diameter side radii section in the condition of having considered as the posture in which the above-mentioned annular crevice is compared to the apical surface of the above-mentioned body. In other words, about the diameter direction of this body, the core of the radius of curvature of the above-mentioned bore side radii section exists in the same location as the core of the radius of curvature of the above-mentioned outer-diameter side radii section, or exists in the direction inside of a path rather than the core of the radius of curvature of this outer-diameter side radii section. And outside, the core of the radius of curvature of this outer-diameter side radii section does not exist about the direction of a path of this body rather than the peripheral face of the above-mentioned body. That is, about the direction of a path of the above-mentioned body, the core of the radius of curvature of the outer-diameter side radii section exists in the same location as the peripheral face of the above-mentioned body, or exists in the direction inside of a path rather than this peripheral face.

[0019]

[Function] according to the manufacture approach of the hub unit for wheel support of this invention constituted as mentioned above, the mean stress of **** which is connected with the inner skin parts of a body and the caulking section with processing of the caulking section at a crack occurs -- there is nothing (when it is claim 1) -- even if it generates, it will stop [ whether it generates and ] at a small value (in the case of claim 2). Moreover, the mean stress of **** of a circumferencial direction does not join the inner ring of spiral wound gasket which the outer diameter of the base of the above-mentioned body did not become large, and was attached outside the step with processing of the above-mentioned caulking section. For this reason, the endurance of the above-mentioned caulking section and the second inner-ring-of-spiral-wound-gasket orbit is raised, and the hub unit for wheel support which has the outstanding endurance can be obtained. If the above-mentioned caulking section is processed using the force plunger for manufacture of the hub unit for wheel support especially indicated to claim 3, it is stabilized and the bundle section in good can be formed.

[0020]

[Embodiment of the Invention] Drawing 1 -2 show one example of the gestalt of operation of this invention. In addition, the description of this invention is related with the amelioration of an approach which is made to carry out plastic deformation of the body 8b formed in the toe of these hub bodies 2 and 2a that an inner ring of spiral wound gasket 3 should be fixed to the hub bodies 2 and 2a, and is set to caulking section 9b. Since it is the same as that of the case of the 2nd example of structure conventionally which was shown in the 1st example or drawing 11 of structure conventionally which was shown in drawing 10 about the basic configuration of the hub unit for wheel support, explanation is omitted in the illustration list about an equivalent part, and is hereafter explained to it focusing on the description part of this invention. In addition, (A) shows hub body 2a to which (B) has the spline hole 26 for the hub body (fullness object) 2 which does not have a feed hole by the object for coupled driving wheels at the core by the object for driving wheels among two kinds of structures shown in drawing 1 , respectively.

[0021] The thickness dimension about the direction of a path of the end face section to the toe of the above-mentioned hub bodies 2 and 2a T, The amount of protrusions concerning [ the thickness dimension about the direction of a path of a point ] the shaft orientations from t and the end face 18 within shaft orientations of an inner ring of spiral wound gasket 3 is h (it is about 5-11mm by the case where it is a general hub unit for wheel support for passenger cars). The above-mentioned body 8b whose die-length dimension about shaft orientations is H (similarly about 7-17mm) is prepared. Each [ these ] dimensions T, t, H, and h are relation with the

dimension of each part of the above-mentioned inner ring of spiral wound gasket 3, and are regulated as follows. In addition, the above-mentioned amount h of protrusions attaches the inner skin of this inner ring of spiral wound gasket 3 outside the above-mentioned body 8b, and says the die length in the condition of having dashed the outer edge surface of this inner ring of spiral wound gasket 3 against the level difference side 25 of a step 7.

[0022] First, the thickness dimension T of the end face section is made into 60 - 100% of the thickness dimension S about the direction of a path of the toe of the above-mentioned inner ring of spiral wound gasket 3 which should be stopped by the above-mentioned caulking section 9b (in the case of the general hub unit [ for wheel support ] for passenger cars, it is about 5-9mm) {T=(0.6-1) S}. The reason for regulating the thickness dimension T of the above-mentioned end face section in such range is for securing the force of suppressing the force of joining the above-mentioned inner ring of spiral wound gasket 3 with formation of the above-mentioned caulking section 9b, and stopping this inner ring of spiral wound gasket 3. When the thickness dimension T of the above-mentioned end face section is less than (T<0.6S) 60% of the thickness dimension S of the toe of the above-mentioned inner ring of spiral wound gasket 3, it may become difficult to secure the force in which the above-mentioned caulking section 9b stops the above-mentioned inner ring of spiral wound gasket 3, and the fixed reinforcement of this inner ring of spiral wound gasket 3 may become inadequate. When the thickness dimension T of the above-mentioned end face section exceeds the thickness dimension S of the toe of the above-mentioned inner ring of spiral wound gasket 3 (T>S), in case plastic deformation of the above-mentioned body 8b is carried out and it is referred to as above-mentioned caulking section 9b on the contrary, the force which turned to the method of the outside of the direction of a path among the force which this body 8b receives from force-plunger 15a becomes large too much to the force of joining shaft orientations. Consequently, possibility that the mean stress of **** will occur in the inner skin thru/or the apical surface of above-mentioned body 8b thru/or caulking section 9b, and a crack will occur into the part concerned arises. In addition, the thickness dimension s of the heel of the above-mentioned inner ring of spiral wound gasket 3 (in the case of the general hub unit [ for wheel support ] for passenger cars, it is about 2-8mm) makes the thickness dimension T of the end face section of the above-mentioned body 8b 60 - 100% of the thickness dimension s of the heel of the above-mentioned inner ring of spiral wound gasket 3 {T= (0.6-1) s}, in being larger than the thickness dimension S of the above-mentioned toe (second>S). However, when the thickness dimension s of this heel is less than 4mm, this thickness dimension s is calculated as 4mm (in the case of s< 4mm, it may be T= 2.4-4mm).

[0023] next, the thickness dimension t of the point of the above-mentioned body 8b -- 70 - 100% of the thickness dimension T of the above-mentioned end face section {t=(0.7-1.0) T} -- it may be 70 - 95% {t=(0.7-0.95) T} still more preferably. This reason is for generating the mean stress (hydrostatic-pressure > 0) of compression to the inner skin of the above-mentioned body 8b throughout this caulking, without making troublesome caulking which sets the above-mentioned body 8b to above-mentioned caulking section 9b. Like the conventional approach shown in above-mentioned drawing 14 , the thickness dimension t of the above-mentioned point in the case of less than (t<0.7T) 70% of the thickness dimension T of the above-mentioned end face section caulking which sets body 8a to caulking section 9a ( drawing 15 ) -- following -- these -- body 8a burn -- making -- a part for the inner skin of section 9a, or an inner edge surface part -- the mean stress (hydrostatic-pressure <0) of **** -- generating -- being easy -- it becomes easy to generate the damage on a crack etc. into the part concerned. On the other hand, when the thickness dimension t of the above-mentioned point exceeds 100% of the thickness dimension T of the above-mentioned end face section (t>1.0T), the volume of the point of the above-mentioned body 8b increases to **, and the activity which processes this body 8b into the above-mentioned caulking section 9b becomes troublesome. Moreover, processing of this body 8b becomes troublesome. In addition, if the thickness dimension t of the above-mentioned point is held down to 95% or less of the thickness dimension T of the above-mentioned end face section, the above-mentioned processing can be made easier.

[0024] Next, the amount h of protrusions about the shaft orientations from the end face 18 within shaft orientations of said inner ring of spiral wound gasket 3 is appropriately regulated

according to the magnitude of caulking section 9b which should be formed. When being set to the above-mentioned caulking section 9b while the above-mentioned body 8b is compressed into shaft orientations and bulges in the method of the inside of the direction of a path is taken into consideration, cross-section die-length [ of the chamfer 20 of the shape of cross-section radii of having formed the above-mentioned amount h of protrusions at the inner end-face inner circumference edge of the above-mentioned inner ring of spiral wound gasket 3 ] h -- ' (in the case of the general hub unit [ for wheel support ] for passenger cars, it is about 4-10mm) -- almost -- being the same (h**h') -- ** -- carrying out is appropriate. However, this relation (h**h') is not necessarily realized, when the configuration and magnitude of the above-mentioned chamfer 20 change. You make it go away after processing, the inner end face of the above-mentioned inner ring of spiral wound gasket 3 is certainly stopped by section 9b, and it becomes unnecessary thus, to perform excessive processing moreover by regulating the above-mentioned amount h of protrusions. In the case of the dimension and a configuration like illustration, if the above-mentioned amount h of protrusions becomes small (h<<h') sharply rather than above-mentioned cross-section die-length h', the above-mentioned inner ring of spiral wound gasket 3 by the above-mentioned caulking section 9b will stop, and the force will become inadequate. On the other hand, if the above-mentioned amount h of protrusions becomes large (h>>h') sharply rather than above-mentioned cross-section die-length h', processing of the above-mentioned caulking section 9b will become troublesome at **.

[0025] Furthermore, the die-length dimension H about said shaft orientations is regulated so that the shaft-orientations location Q of the end face section of the above-mentioned body 8b may similarly exist in before shaft-orientations location P' of the outer edge edge of the inner-ring-of-spiral-wound-gasket orbit 11 from the shaft-orientations location P of the boundary of the body of the inner skin of the above-mentioned inner ring of spiral wound gasket 3, and a chamfer 20. If the shaft-orientations location Q of the above-mentioned end face section exists in the inner direction (upper part of drawing 1 ) from the shaft-orientations location P of the above-mentioned boundary, the die-length dimension of the above-mentioned body 8b will become short too much, and quality reservation of the above-mentioned caulking section 9b will become difficult. Moreover, the force suitable for the method of the outside of the direction of the path which joins the shaft-orientations location Q section of the above-mentioned end face section may become large too much relatively. However, ** is possible also for moving the shaft-orientations location Q of the above-mentioned end face section even to inner end-face 18 part of the above-mentioned inner ring of spiral wound gasket 3 depending on the case once. On the other hand, if the shaft-orientations location Q of the above-mentioned end face section exists in the method of outside [ ' / of the outer edge edge of the above-mentioned inner-ring-of-spiral-wound-gasket orbit 11 / shaft-orientations location P] (lower part of drawing 1 ), the die-length dimension of the above-mentioned body 8b will become long too much, and rigid reservation of the hub bodies 2 and 2a will become difficult. Moreover, by the buckling distortion of the above-mentioned body 8b accompanying caulking, the above-mentioned caulking section 9b does not stick to the chamfer 20 of the above-mentioned inner ring of spiral wound gasket 3, but possibility that a clearance will be generated into the part concerned is also produced.

[0026] Plastic deformation of the body 8b which has the above dimension and configurations is carried out by force-plunger 15a which has the cross-section configuration attached to rocking caulking equipment as shown in drawing 2 , and it is taken as caulking section 9b [ like ] shown in this drawing. The annular crevice 23 is formed in this force-plunger 15a, and by stopping the above-mentioned body 8b in this annular crevice 23, plastic deformation of this body 8b is carried out, and it is referred to as above-mentioned caulking section 9b. It explains about the cross-section configuration of such an annular crevice 23 by the case where the above-mentioned force-plunger 15a is made into a neutral condition (condition which made in agreement the medial axis of the medial axis of this force plunger, above-mentioned body 8b, or caulking section 9b). Although the radius of curvature of the cross-section configuration of the above-mentioned annular crevice 23 is changing gradually about the direction of a path The inclination of change is mutually reverse through the point U of the edge within the direction of a path of the range where the production alpha of the fitting side of the peripheral face of a step 7

and the inner skin 19 of an inner ring of spiral wound gasket 3, the above-mentioned force-plunger 15a, and the above-mentioned caulking section 9b contact bordering on the point on between the straight lines beta parallel to the above-mentioned production alpha (the A range of drawing 2 ). The boundary location (boundary point) which exists in this A within the limits is suitably determined in consideration of the balance of stress. Moreover, the part from which cross-section configurations, such as a flat surface, serve as a straight line may be prepared, and the above-mentioned radius of curvature may be changed to above-mentioned A within the limits bordering on the direction inside-and-outside both ends of a path of this part.

[0027] First, rather than the above-mentioned boundary point, by part for an outer-diameter flank, radius of curvature becomes small comparatively rapidly, so that it goes to the method of the outside of the direction of a path. This reason is for preventing that the amount of [ of above-mentioned body 8b and caulking section 9b ] point generates compressive stress, and the damage on a crack etc. occurs in a part for this point. On the other hand, rather than the above-mentioned boundary point, by part for a bore flank, radius of curvature becomes small comparatively gently, so that it goes to the method of the inside of the direction of a path. This reason is for stopping that the meat of the above-mentioned body 8b flows superfluously to a bore side with a caulking activity, bringing together in the above-mentioned boundary point approach part, and obtaining caulking section 9b with big reinforcement.

[0028] If plastic deformation is carried out by force-plunger 15a which has the annular crevice 23 which has the above cross-section configurations for the above-mentioned body 8b which has the above cross-section configurations, some metallic materials which constitute the above-mentioned body 8b will move to the method of the inside of the direction of a path, and the bulge section 24 which swelled into the bore part of this caulking section 9b after the completion of formation of the above-mentioned caulking section 9b at the method of the inside of the direction of a path will be formed. That is, if the cross-section configuration about the virtual flat surface containing the medial axis of caulking section 9b obtained by the approach of this invention is applied to shaft-orientations pars intermedia from the end face section (lower limit section of drawing 2 ), thickness increases gradually, and if it applies to a point (upper limit section of drawing 2 ) from pars intermedia, thickness decreases gradually. And in the bending part of a point, thickness decreases rapidly, so that it goes to the method of the outside of the direction of a path. In addition, as for the thickness of the above-mentioned pars intermedia, the thick twist of the above-mentioned body 8b from the first in the part concerned also becomes large.

[0029] The more concrete configuration of caulking section 9b formed in the toe of the hub bodies 2 and 2a by the approach of this invention at (A) of drawing 3 and (B) is shown. Among these, drawing 3 (A) shows the case where caulking section 9b is formed in the toe of hub body 2a where drawing 3 (B) has the spline hole 26 for the case where caulking section 9b is formed in the toe of the hub body 2 which does not have a feed hole by the object for coupled driving wheels (fullness object), at the core by the object for driving wheels, respectively. When the caulking section is formed in the toe of the hub body which had a feed hole by the object for coupled driving wheels, it is also the same as that of drawing 3 (B). On the other hand, drawing 3 (C) shows the case where caulking section 9a is formed in the toe of the hub body 2 which does not have a feed hole by the object for coupled driving wheels by the conventional approach. If such drawing 3 (C), above-mentioned drawing 3 (A), and (B) are compared, in caulking section 9b formed by the approach of this invention, the bulge section 24 which swelled to the method of the inside of the direction of a path will be formed in the bore part of this caulking section 9b a clear passage. Even if it is built when some metallic materials with which this bulge section 24 constitutes body 8b (refer to drawing 1 ) move to the method of the inside of the direction of a path, and compressive mean stress continued joining this metallic material at that time or the mean stress of **** occurs, having stopped at the small value will be clear. On the other hand, in caulking section 9a built by the conventional approach shown in drawing 3 (C), it is clear that the whole is made to carry out plastic deformation to the method of the outside of the direction of a path, and the mean stress of **** continued joining a metallic material on the occasion of this plastic deformation. Where compressive stress is added into a metallic material, when the

mean stress of **** is added to the force which restores this even when the signs of a crack arise in this metallic material being added, the force of a direction of increasing a crack is added. These things show that the yield which was made to damage the above-mentioned caulking section 9b, and was hard and excellent can be obtained according to this invention.

[0030] Furthermore, when carrying out this invention, one side or the both sides of processing to which surface roughness, such as processing for raising abrasion resistance, such as ceramic coating like TiN, preferably to the inside for the press surface part 23 to which plastic deformation of this body 8b is carried out in contact with the above-mentioned body 8b on the front face of the above-mentioned force-plunger 15a (i.e., the above-mentioned annular crevice), or shot peening, is reduced is given. And the abrasion resistance of the inside of the above-mentioned annular crevice 23 is raised, or coefficient of friction of the inside of this annular crevice 23 is stabilized in 0.3 or more comparatively big values.

[0031] In case the above-mentioned body 8b is processed into the above-mentioned caulking section 9b using rocking caulking equipment, these bodies 8b or caulking section 9b, and the inside of the above-mentioned annular crevice 23 rub strongly. such, if abrasion resistance is raised -- strong -- irrespective of rubbing, wear of the above-mentioned annular crevice 23 is suppressed, and improvement in endurance of the above-mentioned force-plunger 15a can be aimed at. Moreover, damage on a crack etc. can be made hard to generate in caulking section 9b which it could continue making able to generate the mean stress of compression to above-mentioned body 8b or caulking section 9b throughout caulking, and was obtained, if coefficient of friction is stabilized in a big value.

[0032] Namely, although it will become easy to generate the damage on a crack etc. into the part concerned if the mean stress of **** joins the pars intermedia or tip approach part of these bodies 8b or caulking section 9b in case plastic deformation of the above-mentioned body 8b is carried out and it is referred to as above-mentioned caulking section 9b By carrying out plastic deformation of the body 8b in which each has the above configurations by force-plunger 15a, compressive mean stress can be made to be able to act on the above-mentioned part, and generating of the damages on the above-mentioned crack etc. can be suppressed. And by enlarging coefficient of friction of the inside of the above-mentioned annular crevice 23, compressive mean stress can be made to act on the above-mentioned part more certainly, and the generating prevention effectiveness of the damages on the above-mentioned crack etc. can be ensured.

[0033] In addition, although coefficient of friction of this annular crevice 23 is 0.05 to about 0.2 when not performing surface treatment to especially the above-mentioned annular crevice 23 formed in steel force-plunger 15a, about with 0.3 to 0.5, coefficient of friction at the time of performing said ceramic coating like TiN is large, and, moreover, is stabilized. Good caulking section 9b can be built with a high yield, without generating the damage on a crack etc., if plastic deformation of the above-mentioned body 8b is carried out and the above-mentioned caulking section 9b is formed, without using force-plunger 15a which performed such ceramic coating, and making lubricant placed between the processing sections. In addition, if shot peening is performed to the surface part of the above-mentioned annular crevice 23 after giving the front stirrup which performs the above-mentioned ceramic coating, coefficient of friction of this annular crevice 23 part becomes higher, and it can obtain bundle section 9in good b more. In addition, even when only shot peening is performed without performing ceramic coating, compared with the case where surface treatment is not performed at all, wear-resistant improvement and increase of coefficient of friction can be aimed at to the above-mentioned annular crevice 23.

[0034] Next, when carrying out this invention, it explains about the desirable configuration of force-plunger 15a used in the condition of having included in rocking caulking equipment. Namely, the period throughout processing which is made to carry out plastic deformation of the point of body 8b formed in the toe of Hubs 2 and 2a to the method of the outside of the direction of a path, and is set to caulking section 9b, Even if it continues generating the mean stress of compression into the inner skin part of the above-mentioned body 8b or the mean stress of **** occurs, in order to stop to a small value, the configuration of this body 8b is devised, and

also it is necessary to devise the configuration of force-plunger 15a dashed against the apical surface of this body 8b. As shown in drawing 4 which following-** as this force-plunger 15a, it pushes in inside the above-mentioned body 8b, and what formed the heights 16 of the shape of a free truncated cone in these heights 16 and this alignment, respectively in the condition of surrounding the perimeter of these heights 16 for the annular crevice 23 around these heights 16 in the apical surface center section is used. In such force-plunger 15a, the cross-section configuration of the above-mentioned annular crevice 23 becomes important especially. Although considering as the compound curved surface which the radii of varieties are made to continue and changes like the structure indicated by above-mentioned JP,10-272903,A in this cross-section configuration is also considered, processing of such a compound curved surface is troublesome, and becomes the cause by which the manufacturing cost of the above-mentioned force-plunger 15a increases. So, in the following examples, it is only two kinds of radii which have radius of curvature which is mutually different in the cross-section configuration of the part with which processing of the above-mentioned body 8b is presented among the above-mentioned annular crevices 23, or explains about the case where it constitutes from two kinds of radii, and a bay.

[0035] First, as a fundamental cross-section configuration of the suitable above-mentioned annular crevice 23 for operation of this invention, as shown in drawing 4 , the configuration which the periphery edge of the bore side radii section 27 and the inner circumference edge of the outer-diameter side radii section 28 were made to follow smoothly can be considered. The radius of curvature R27 (in the case of the general hub unit [ for wheel support ] for passenger cars, it is about 3-13mm) of the bore side radii section 27 which exists in a bore approach part among both [ these ] the radii sections 27 and 28 is made larger than the radius of curvature R28 (similarly about 3-7mm) of the outer-diameter side radii section 28 which exists in an outer-diameter approach part. In this example, as shown in above-mentioned drawing 4 , the core of both [ these ] the radius of curvatures R27 and R28 is in the condition made into the posture in which the above-mentioned annular crevice 23 is compared to the apical surface of the above-mentioned body 8b, and is located on an parallel single virtual straight line to the medial axis of this body 8b.

[0036] Namely, as for medial-axis I of the above-mentioned force-plunger 15a forced on the point of the above-mentioned body 8b in the condition of having attached to rocking caulking equipment, only few include angles (for example, 2 or less times) theta incline to medial-axis RO of this body 8b. Therefore, the above-mentioned annular crevice 23 will be in the condition that a part of circumferencial direction was forced on the point of the above-mentioned body 8b as shown in drawing 5 . the part forced -- rocking of the above-mentioned force-plunger 15a -- in connection with a variation rate, it changes to a circumferencial direction, and the above-mentioned body 8b is made to carry out plastic deformation little by little continuously about a hoop direction as a result For this reason, about the above-mentioned annular crevice 23, the cross-section configuration of the part ( drawing 4 R> right-hand side parts of 4-5) actually forced on the point of the above-mentioned body 8b becomes important. Then, about the cross-section configuration of the above-mentioned annular crevice 23, as shown in drawing 4 -5, this annular crevice 23 is discussed in the condition of having considered as the posture compared to the apical surface of the above-mentioned body 8b. Therefore, the description about this cross-section configuration is not realized in the right-hand side part of drawing 4 -5 dashed against the apical surface of the above-mentioned cylinder side 8b as they are, when force-plunger 15a and the hub bodies 2 and 2a are brought close, and it is not realized in the left-hand side part of drawing 4 -5 which are not dashed.

[0037] The core of the radius of curvature R27 of the bore side radii section 27 which exists in a bore approach part like which was mentioned above in the case of the structure shown in drawing 4 , While locating the core of the radius of curvature R28 of the outer-diameter side radii section 28 which exists in an outer-diameter approach part on an parallel single virtual straight line to medial-axis RO of the above-mentioned body 8b The amount gamma of gaps of both the above-mentioned cores about the shaft orientations of this virtual straight line is made in agreement with the difference (R27-R28=gamma) of both the above-mentioned radius of

curvatures. Therefore, the periphery edge of the above-mentioned bore side radii section 27 and the periphery edge of the above-mentioned outer-diameter side radii section 28 are continuing smoothly by being extended mutually in a tangential direction. Moreover, the above-mentioned virtual straight line in which both the above-mentioned radius of curvatures R27 and R28 are located is in the condition made into the posture in which the above-mentioned annular crevice 23 is too compared to the apical surface of the above-mentioned body 8b, and, outside, does not exist rather than the peripheral face of this body 8b about the direction of a path of this body 8b and the above-mentioned force-plunger 15a.

[0038] That is, the above-mentioned virtual straight line exists in a bore side (medial-axis RO approach of the above-mentioned body 8b) rather than this chain-line Ha in accordance with chain-line Ha who extended the bus-bar of the peripheral face of the above-mentioned body 8b. However, even when preparing in bore approach, the distance (variation rate amount) of the above-mentioned virtual straight line and above-mentioned chain-line Ha is stopped to 1.0mm (still more preferably 0.5mm) extent. Thus, by regulating the location of both the above-mentioned radius of curvatures R27 and R28, the prevention force of inner-ring-of-spiral-wound-gasket 3b by obtained caulking section 9b is secured, and, moreover, damage prevention of the above-mentioned force-plunger 15a can be aimed at. Drawing 6 -7 explain about the result of the experiment which this invention person conducted about this point.

[0039] First, drawing 6 is shown about the relation between the above-mentioned amount of displacement, and the size of the prevention force of inner-ring-of-spiral-wound-gasket 3b by obtained caulking section 9b. The axis of ordinate of this drawing 6 is the force (it is the culmination of processing of the above-mentioned caulking section 9b) which pressed inner-ring-of-spiral-wound-gasket 3b to the method of the outside of shaft orientations by the above-mentioned force-plunger 15a when forming the above-mentioned caulking section 9b. Force F1 of the shaft orientations added to the above-mentioned inner-ring-of-spiral-wound-gasket 3b through this caulking section 9b Force F2 in which the above-mentioned caulking section 9b is pressing the above-mentioned inner-ring-of-spiral-wound-gasket 3b to the method of the outside of shaft orientations after removing the thrust of this receiving force-plunger 15a It expresses comparatively (F2 / F1). Since the burden which leads to the force which the above-mentioned force-plunger 15a applies being suppressed small, and big caulking section 9b of the prevention force of the above-mentioned inner-ring-of-spiral-wound-gasket 3b being formed, and joins this inner-ring-of-spiral-wound-gasket 3b at the time of caulking can be reduced so that this rate is large, it is desirable. moreover, the numeric value indicated on the axis of abscissa of drawing 6 -- the above -- a variation rate -- the amount is expressed. In addition, "+" means, respectively that it is located in a bore side as well as "-" that the above-mentioned virtual straight line is located in an outer-diameter side rather than chain-line Ha to whom this amount of displacement extended the bus-bar of the peripheral face of the above-mentioned body 8b, and that the above-mentioned virtual straight line is located on above-mentioned chain-line Ha in amount =of displacement 0. according to the experiment which this invention person conducted -- the above -- a variation rate -- the specification required of the above-mentioned caulking section 9b was satisfied in the range whose amount is -1-+1.1mm. However, the case of +0.64mm, and in the case of +1.1mm, it was smaller than the case where the above-mentioned rates are others. Moreover, in the case of -1mm, under-fill arose at a part of obtained caulking section 9b. On the other hand, in the case of 0mm and -0.5mm, the above-mentioned rate was large, and the appearance of obtained caulking section 9b was also good.

[0040] Next, drawing 7 shows the relation between the above-mentioned amount of displacement, and the magnitude of the force of joining the above-mentioned force-plunger 15a at the time of caulking. The semantics of the axis of abscissa of this drawing 7 is the same as above-mentioned drawing 6 . Moreover, damage on a crack etc. is made hard to generate in this force-plunger 15a, the endurance of this force-plunger 15a is secured, and it leads to the ability of a production cost to be held down low, so that the magnitude of the force of joining the above-mentioned force-plunger 15a at the time of caulking expressed to the axis of ordinate of this drawing 7 is small. That is, if the above-mentioned force becomes large, the big force will join the part which surrounds said annular crevice 23 in the periphery approach part of the

above-mentioned force-plunger 15a, and it will become easy to produce a crack into this part from the base side of this annular crevice 23. Since exchange of the above-mentioned force-plunger 15a is needed and the part manufacturing cost increases when such a crack arises, the above-mentioned force is so desirable that it is small. according to the experiment which this invention person conducted -- the above -- a variation rate -- when an amount was 0mm, the above-mentioned force was the smallest and the case where it was -0.5mm followed it. When this amount of displacement was +0.64mm and +1.1mm, the above-mentioned force became large and it was checked that endurance reservation of force-plunger 15a is difficult. In addition, since under-fill arose in caulking section 9b obtained as mentioned above when the above-mentioned amount of displacement was -1mm, it did not indicate to drawing 7 . The result of such drawing 7 also shows that the case (also the same as when [ Natural ] it is the middle value) where they are the case where said amount of displacement is 0mm, and -0.5mm is desirable.

[0041] Next, drawing 8 explains the periphery edge of the bore side radii section 27, and the inner circumference edge of the outer-diameter side radii section 28 about the case where it is made to continue through a bay 29, about the cross-section configuration of the annular crevice 23 of force-plunger 15a. When forming such a bay 29, the maximum hydrostatic pressure which joins caulking section 9b at the time of shaping can be stopped by the ability shifting the core of the radius of curvature R27 of the above-mentioned bore side radii section 27 a little to a bore side about the direction of a path of the hub bodies 2 and 2a rather than the core of the center of curvature R28 of the above-mentioned outer-diameter side radii section 28. Drawing 9 explains about the result of the experiment which this invention person conducted about this point. In this experiment, in addition, the core of the center of curvature R28 of the above-mentioned outer-diameter side radii section 28 You make it located on the production (chain-line Ha) of the bus-bar (bus-bar of the inner skin of the = inner ring of spiral wound gasket 3) of the peripheral face of body 8b of the above-mentioned hub body 2a. The distance delta about the direction of a path of the above-mentioned body 8b of this production and the core of the radius of curvature R27 of the above-mentioned bore side radii section 27 (variation rate amount) was changed, and it asked for the effect the difference in this amount delta of displacement affects the above-mentioned maximum hydrostatic pressure.

[0042] It is drawing 9 which shows the result of the experiment conducted on such conditions, and the case where the amount of displacement expressed with the axis of abscissa is 0mm is the same as the case where the amount of displacement is 0mm in the above-mentioned drawing 4 -7. Moreover, in -0.5mm - 1mm, when the core of the radius of curvature R27 of the above-mentioned bore side radii section 27 exists in 0.5mm or the part shifted 1mm, respectively inside the production (chain-line Ha) of the bus-bar of the peripheral face of body 8b of the above-mentioned hub body 2a, it shows { drawing 8 (A)}. in addition, drawing 8 (B) -- the above -- a variation rate -- the amount shows the configuration to which the core of the above-mentioned radius of curvature R27 exists outside the production (chain-line Ha) of "+, i.e., the above-mentioned bus-bar," and which is not desirable.

[0043] If the core of the radius of curvature R27 of the above-mentioned bore side radii section 27 is located inside the core of the center of curvature R28 of the above-mentioned outer-diameter side radii section 28 a passage clear from the experiment conducted on such conditions, the maximum hydrostatic pressure which joins caulking section 9b at the time of shaping can be stopped. Therefore, when the ductility of the metallic material which constitutes the above-mentioned hub bodies 2 and 2a is low, it is possible to set up the above-mentioned bay 29 and to stop the maximum hydrostatic pressure which joins caulking section 9b at the time of shaping. However, if the die length delta of displacement of the above-mentioned bay 29, i.e., the above-mentioned amount, exceeds 1mm, since under-fill may arise in a part of caulking section 9b obtained, as for this amount delta of displacement, it is desirable to hold down to 1mm or less.

[0044]

[Effect of the Invention] Since the manufacture approach and the force plunger for manufacture of the hub unit for wheel support of this invention are constituted as they were stated above,

and they act, immobilization of the inner ring of spiral wound gasket to a hub body can be ensured, and implementation of the hub unit for wheel support which can fully secure the rolling contact fatigue life of the inner-ring-of-spiral-wound-gasket orbit moreover formed in the peripheral face of this inner ring of spiral wound gasket can be aimed at.

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[Translation done.]

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1] The fragmentary sectional view showing one example of the gestalt of implementation of the manufacture approach of the hub unit for wheel support of this invention in the condition before forming the caulking section.
[Drawing 2] The fragmentary sectional view shown in the condition after forming this caulking section.
[Drawing 3] Drawing showing the cross-section configuration of the caulking section obtained by the approach of this invention, and the caulking section obtained by the conventional approach.
[Drawing 4] The sectional view shown in the condition of not making it still contacting while it had been made countering with the hub body in which one example of the gestalt of operation of the force plunger for manufacture of the hub unit for wheel support of this invention is shown.
[Drawing 5] The sectional view showing processing of the caulking section in the condition of having completed mostly, similarly.
[Drawing 6] The graph which shows the result of the experiment conducted in order that a difference of the cross-section configuration of the crevice of a force plunger might know the effect affect the magnitude of the force of stopping the inner ring of spiral wound gasket of the obtained caulking section.
[Drawing 7] The graph which shows the result of the experiment conducted in order to know the effect affect the magnitude of the force of similarly joining a force plunger.
[Drawing 8] The partial expanded sectional view showing example of another of the cross-section configuration of the crevice of a force plunger.
[Drawing 9] The graph which shows the result of the experiment conducted in order that a difference of the cross-section configuration of the crevice of a force plunger might know the effect affect the maximum of the hydrostatic stress added at the time of processing of the caulking section.
[Drawing 10] The sectional view showing the 1st example of structure conventionally.
[Drawing 11] The sectional view showing this 2nd example.
[Drawing 12] The fragmentary sectional view showing the condition of forming the caulking section by the conventional approach.
[Drawing 13] The fragmentary sectional view for similarly explaining the cross-section configuration of the caulking section.
[Drawing 14] The fragmentary sectional view shown in the condition before forming the caulking section similarly.

[Drawing 15] The fragmentary sectional view showing the condition of similarly forming the caulking section.
[Description of Notations]
1 Hub Unit for Wheel Support
2 2a Hub body
3, 3a, 3b Inner ring of spiral wound gasket
4 Outer Ring of Spiral Wound Gasket
5 Rolling Element
6 Flange
7 Step
8, 8a, 8b Body
9, 9a, 9b Caulking section
10 Outer-Ring-of-Spiral-Wound-Gasket Orbit
11 Inner-Ring-of-Spiral-Wound-Gasket Orbit
12 Attachment Section
13 Taper Hole
14 Piece of Prevention
15 15a Force plunger
16 Heights
17 Crevice
18 Inner End Face
19 Inner Skin
20 Chamfer
21 Inner Skin
23 Annular Crevice
24 Bulge Section
25 Level Difference Side
26 Spline Hole
27 Bore Side Radii Section
28 Outer-Diameter Side Radii Section
29 Bay

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[Translation done.]

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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DRAWINGS

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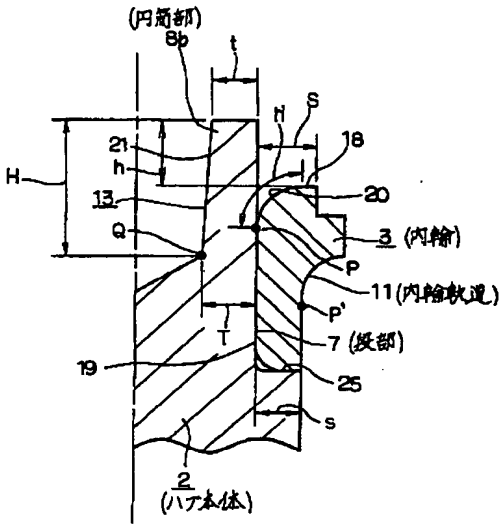
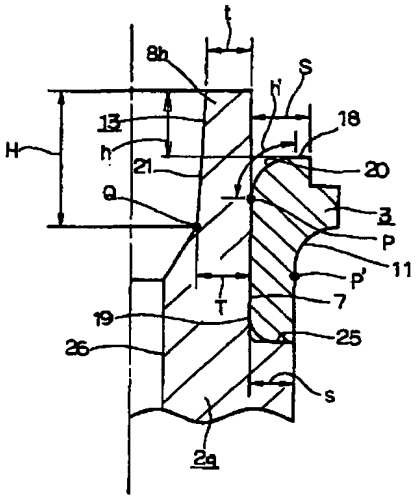
[Drawing 1]

(A)




(B)

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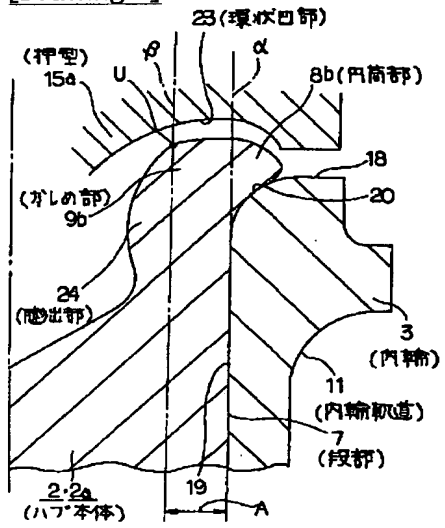


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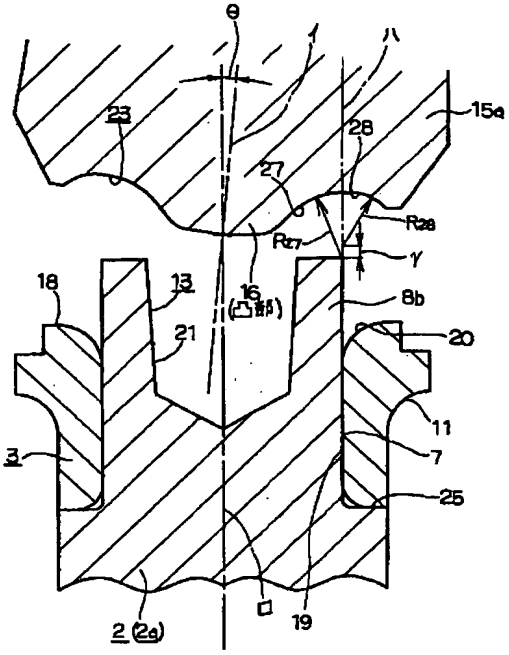


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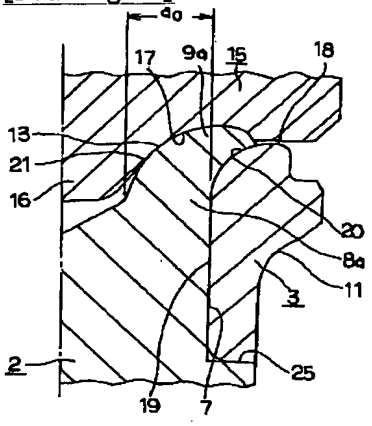


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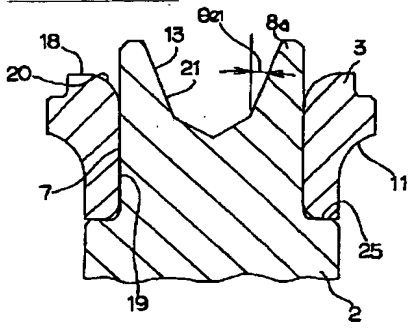


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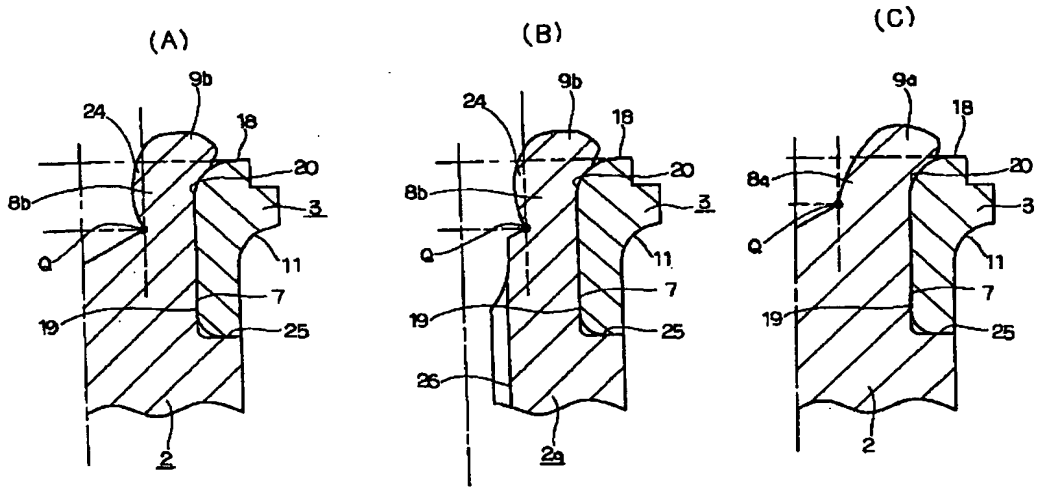


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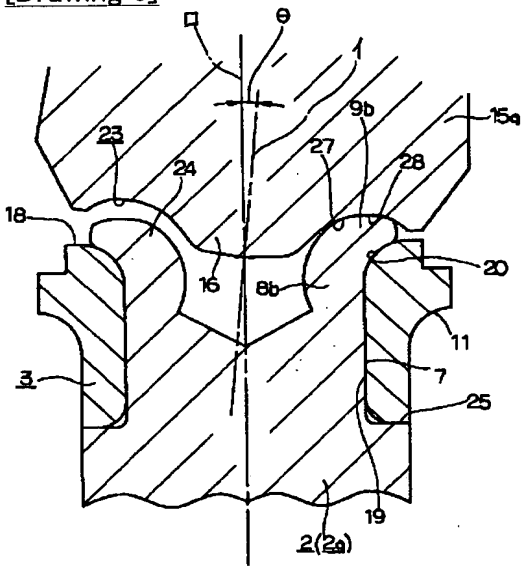


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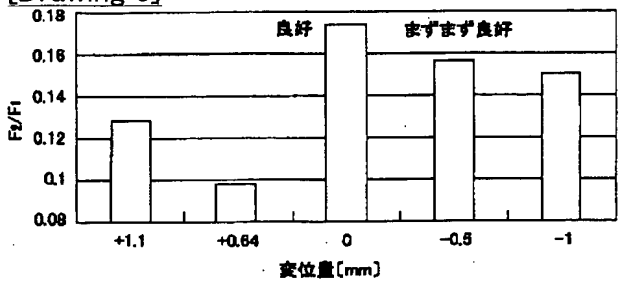


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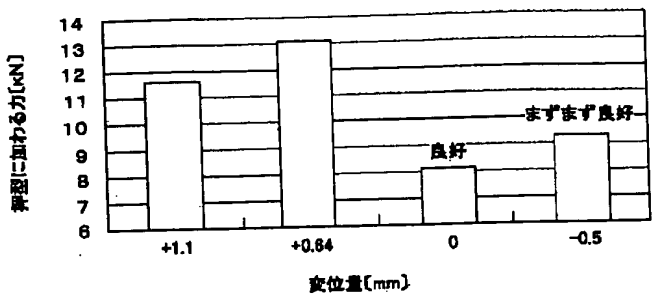


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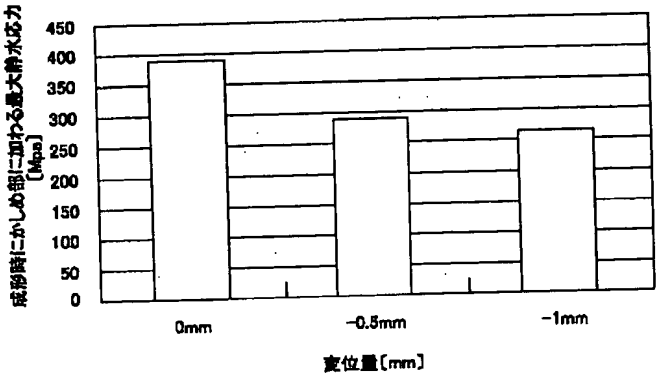


[Drawing 8]

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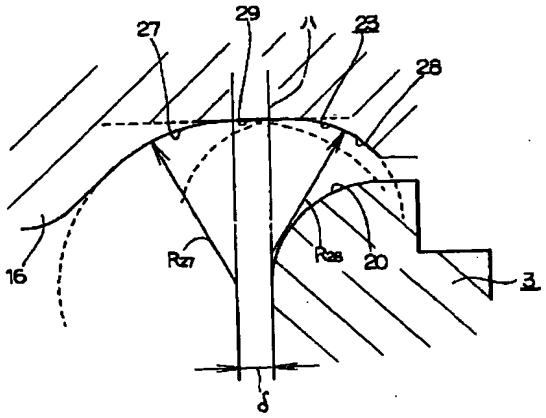
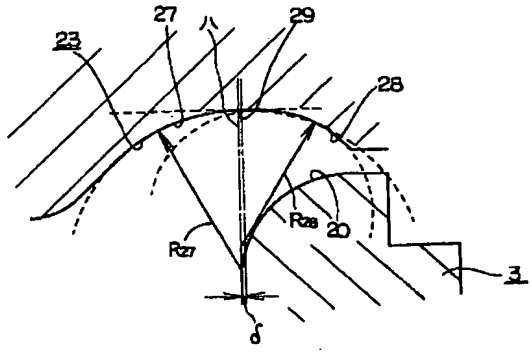



(B)



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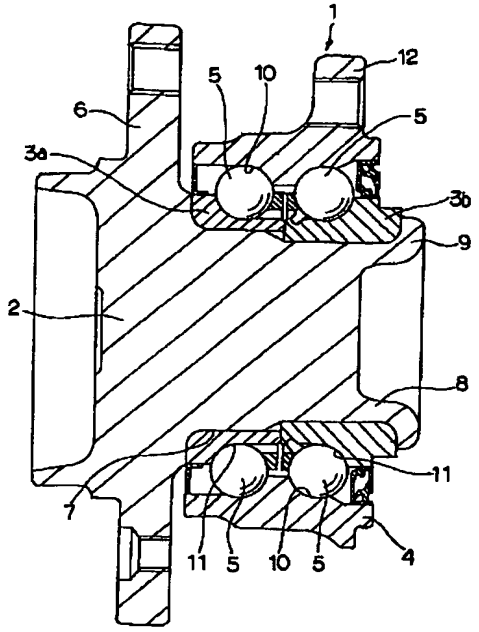


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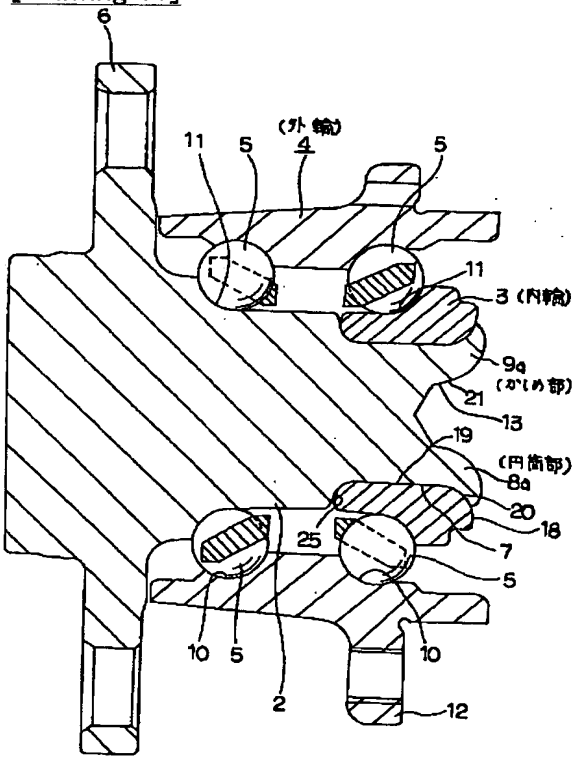


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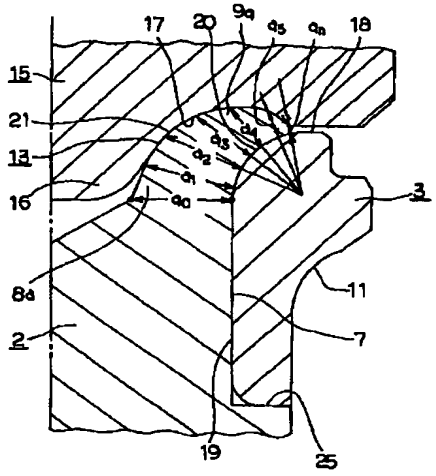
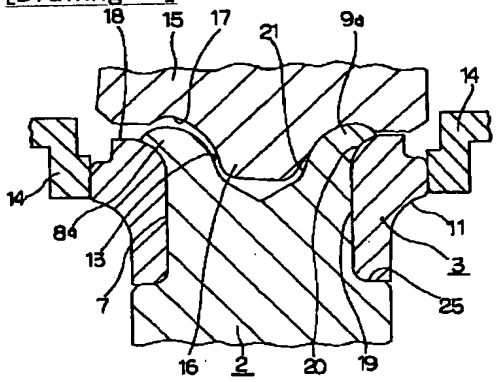



[Drawing 15]

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| 35/18 | | 35/18 | Ａ | |
| Ｆ１６Ｃ　33/60 | | Ｆ１６Ｃ　33/60 | | |

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(71)出願人　000004204
日本精工株式会社
東京都品川区大崎１丁目６番３号
(72)発明者　荻原　信行
神奈川県藤沢市鵠沼神明一丁目５番50号
日本精工株式会社内
(72)発明者　掘家　章史
神奈川県藤沢市鵠沼神明一丁目５番50号
日本精工株式会社内
(74)代理人　100087457
弁理士　小山　武男　（外１名）

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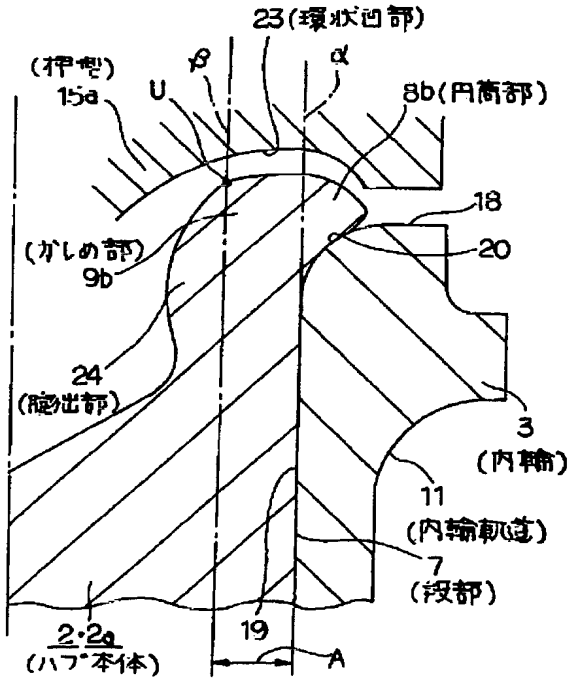
AA72 BA77 FA31 GA03

(54)【発明の名称】　車輪支持用ハブユニットの製造方法とその製造用押型

(57)【要約】
【課題】　ハブ本体２、２ａに対し内輪３を抑え付ける為のかしめ部９ｂの加工に伴って、このかしめ部９ｂに亀裂が生じたり、内輪軌道１１の転がり疲れ寿命が低下する事を防止する。
【解決手段】　上記かしめ部９ｂとすべき円筒部８ｂの形状や、この円筒部８ｂを塑性変形する為の押型１５ａの環状凹部２３の断面形状を工夫する事により、加工の間中、上記かしめ部９ｂの圧縮の平均応力を加え続ける。



【特許請求の範囲】

【請求項１】　一端部外周面に車輪を支持する為のフランジを形成したハブ本体と、このハブ本体の中間部外周面に、直接又はこのハブ本体とは別体の内輪を介して形成した第一の内輪軌道と、上記ハブ本体の他端部に形成された、この第一の内輪軌道を形成した部分よりも外径寸法が小さくなった段部と、外周面に第二の内輪軌道を形成して上記段部に外嵌された内輪と、内周面に上記第一の内輪軌道に対向する第一の外輪軌道及び上記第二の内輪軌道に対向する第二の外輪軌道を形成した外輪と、上記第一、第二の内輪軌道と上記第一、第二の外輪軌道との間に、それぞれ複数個ずつ設けられた転動体とを備え、上記ハブ本体の他端部で少なくとも上記段部に外嵌した内輪よりも突出した部分に形成した円筒部を直径方向外方に塑性変形させる事で形成したかしめ部により、上記段部に外嵌した内輪をこの段部の段差面に向け抑え付けて、この段部に外嵌した内輪を上記ハブ本体に結合固定した車輪支持用ハブユニットを造る為、上記円筒部を塑性変形させて上記かしめ部とする車輪支持用ハブユニットの製造方法に於いて、押型をこの円筒部の先端面に突き当てた状態のまま、この押型からこの円筒部に、軸方向の力及び径方向外方に向いた力を付与して、この円筒部を軸方向に圧縮しつつこの円筒部の先端部を径方向外方に塑性変形させて上記かしめ部とする事により、このかしめ部の加工の間中、上記円筒部の内周面部分に圧縮の平均応力を発生させ続ける事を特徴とする車輪支持用ハブユニットの製造方法。

【請求項２】　一端部外周面に車輪を支持する為のフランジを形成したハブ本体と、このハブ本体の中間部外周面に、直接又はこのハブ本体とは別体の内輪を介して形成した第一の内輪軌道と、上記ハブ本体の他端部に形成された、この第一の内輪軌道を形成した部分よりも外径寸法が小さくなった段部と、外周面に第二の内輪軌道を形成して上記段部に外嵌された内輪と、内周面に上記第一の内輪軌道に対向する第一の外輪軌道及び上記第二の内輪軌道に対向する第二の外輪軌道を形成した外輪と、上記第一、第二の内輪軌道と上記第一、第二の外輪軌道との間に、それぞれ複数個ずつ設けられた転動体とを備え、上記ハブ本体の他端部で少なくとも上記段部に外嵌した内輪よりも突出した部分に形成した円筒部を直径方向外方に塑性変形させる事で形成したかしめ部により、上記段部に外嵌した内輪をこの段部の段差面に向け抑え付けて、この段部に外嵌した内輪を上記ハブ本体に結合固定した車輪支持用ハブユニットを造る為、上記円筒部を塑性変形させて上記かしめ部とする車輪支持用ハブユニットの製造方法に於いて、押型をこの円筒部の先端面に突き当てた状態のまま、この押型からこの円筒部に、軸方向の力及び径方向外方に向いた力を付与して、この円筒部を軸方向に圧縮しつつこの円筒部の先端部を径方向外方に塑性変形させて上記かしめ部を形成するのに伴って、この円筒部を構成する金属材料の一部を径方向内方に移動させて、上記かしめ部の形成完了後にこのかしめ部の内径部分に、径方向内方に膨らんだ膨出部を形成する事を特徴とする車輪支持用ハブユニットの製造方法。

【請求項３】　請求項２に記載した車輪支持用ハブユニットの製造方法を実施する際に、円筒部の先端面に突き当ててこの円筒部に軸方向の力及び径方向外方に向いた力を付与する車輪支持用ハブユニットの製造用押型であって、先端面中央部に形成された、上記円筒部の内側に押し込み自在な円すい台状の凸部と、この凸部の周囲にこの凸部の全周を囲む状態で形成された環状凹部とを備え、この環状凹部の断面形状は、内径寄り部分に存在する内径側円弧部と、外径寄り部分に存在してこの内径側円弧部よりも小さな曲率半径を有する外径側円弧部とを、直接又は直線部を介して滑らかに連続させたものであり、上記環状凹部を上記円筒部の先端面に突き合わせる姿勢とした状態で、上記内径側円弧部の曲率半径の中心は、上記外径側円弧部の曲率半径の中心よりも、上記円筒部の直径方向に関して外側には存在せず、且つ、上記外径側円弧部の曲率半径の中心は、上記円筒部の外周面よりも、この円筒部の径方向に関して外側には存在しない事を特徴とする車輪支持用ハブユニットの製造用押型。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明に係る車輪支持用ハブユニットの製造方法とその製造用押型は、自動車の車輪を懸架装置に対して回転自在に支持する為の車輪支持用ハブユニットを造る為に利用する。

【０００２】

【従来の技術】自動車の車輪は、車輪支持用ハブユニットにより懸架装置に支持する。図１０は、米国特許第５４９０７３２号明細書に記載されている車輪支持用ハブユニットの１例を示している。この車輪支持用ハブユニット１は、ハブ本体２と、１対の内輪３ａ、３ｂと、外輪４と、複数個の転動体５、５とを備える。このうちのハブ本体２の外周面の外端部（外とは、自動車への組み付け状態で幅方向外寄りとなる側を言い、図１０の左側となる。反対に幅方向中央寄りとなる側を内と言い、図１０の右側となる。）には、車輪を支持する為のフランジ６を形成している。又、このフランジ６の基端部で上記ハブ本体２の中央寄り部分には、段部７を形成している。

【０００３】上記１対の内輪３ａ、３ｂは、上記ハブ本体２の中間部から内端部に至る部分に外嵌し、このうち外側の内輪３ａの外端面を上記段部７の段差面に、内側の内輪３ｂの外端面を上記外側の内輪３ａの内端面に、それぞれ突き当てている。尚、内側の内輪３ｂから見た場合、外側の内輪３ａの内端面が、段部の段差面とな

る。又、上記ハブ本体２の内端部には円筒部８を形成し、この円筒部８の先半部で上記内側の内輪３ｂの内端面よりも内方に突出した部分を直径方向外方に塑性変形させて、かしめ部９を形成している。そして、このかしめ部９と上記段部７の段差面との間で、上記１対の内輪３ａ、３ｂを挟持している。

【０００４】又、上記外輪４の内周面に設けた１対の（第一、第二の）外輪軌道１０、１０と、上記各内輪３ａ、３ｂの外周面に設けた（第一、第二の）内輪軌道１１、１１との間には上記転動体５、５を、それぞれ複数個ずつ設けている。尚、図示の例では、転動体５、５として玉を使用しているが、重量の嵩む自動車用の車輪支持用ハブユニットの場合には、これら転動体としてテーパころを使用する場合もある。又、フランジ６寄りの（第一の）内輪軌道１１は、上記ハブ本体２の外周面に直接形成して、外側の内輪３ａを省略する場合もある。この場合に上記段部７は、図１０に示した外側の内輪３ａの内方に相当する位置に形成する。

【０００５】上述の様な車輪支持用ハブユニット１を自動車に組み付けるには、上記外輪４の外周面に形成した外向フランジ状の取付部１２により、この外輪４を懸架装置に固定し、上記フランジ６に車輪を固定する。この結果、この車輪を懸架装置に対し回転自在に支持する事ができる。

【０００６】更に、特開平１０－２７２９０３号公報には、内輪の固定作業時にかしめ部に割れ（クラック）等の損傷を発生しにくくすると共に、かしめ付け作業に伴って上記内輪の内径やこの内輪の外周面に形成した内輪軌道の直径が変化しにくくする構造が記載されている。図１１～１５は、上記公報に記載された、従来構造の第２例及びその製造方法を示している。

【０００７】ハブ本体２の内端部に形成した、内輪３を固定するかしめ部９ａを構成する為の円筒部８ａの肉厚は、図１４に示した、この円筒部８ａを直径方向外方にかしめ広げる以前の状態で、先端縁に向かう程小さくなっている。この為に上記ハブ本体２の内端面に、奥部に向かう程次第に内径が小さくなるテーパ孔１３を形成している。

【０００８】上記ハブ本体２の内端部に上記内輪３を固定すべく、上述の様な円筒部８ａの先端部をかしめ広げるには、上記ハブ本体２が軸方向にずれ動かない様に固定すると共に、図１５に示す様に、抑え片１４により上記内輪３の外周面を抑え付け、この内輪３を外嵌した上記ハブ本体２が直径方向にぶれるのを防止した状態で、同図に示す様に、押型１５を上記円筒部８ａの先端部に強く押し付ける。この押型１５の先端面（図１５の下端面）中央部には、上記円筒部８ａの内側に押し込み自在な円すい台状の凸部１６を形成し、この凸部１６の周囲に断面円弧状の凹部１７を、この凸部１６の全周を囲む状態で形成している。

【０００９】一方、上記かしめ部９ａにより上記ハブ本体２の内端（図１１の右端、図１２～１５の上端）部に固定する為の内輪３の内端開口部周囲には、この内輪３の中心軸に対して直交する平坦面である内端面１８を設けている。そして、この内端面１８の内周縁と、円筒面である上記内輪３の内周面１９とを、断面円弧状の曲面である面取り部２０により連続させている。

【００１０】内端部の形状を上述の様にした上記内輪３を、上記ハブ本体２の段部７に抑え付ける為の上記かしめ部９ａは、上記円筒部８ａを直径方向外方にかしめ広げる事により構成するものであり、その肉厚は、上記円筒部８ａの基端部の肉厚$a_0$（図１２）に対し、先端に向かうに従って漸減する。即ち、図１３に示す様に、上記かしめ部９ａの基端部の肉厚を$a_0$とし、先端部に向かうに従ってこのかしめ部９ａの肉厚が$a_0$、$a_1$、$a_2$－－－$a_n$の順で変化するが、これら各部の厚さの関係が$a_0 > a_1 > a_2 > --- > a_n$になる様に、且つ、上記かしめ部９ａの先端縁部の厚さ$a_n$も零とならない様に（$a_n > 0$）、このかしめ部９ａを形成する為の、前記凸部１６及び凹部１７の断面形状を規制している。

【００１１】この様な凸部１６と凹部１７とを有する押型１５を揺動かしめ装置に組み付けて、この押型１５を上記円筒部８ａの先端部に押し付ければ、この円筒部８ａの先端部を直径方向外方にかしめ広げて、上記かしめ部９ａを形成する事ができる。そして、このかしめ部９ａとハブ本体２の内端部に形成した段部７の段差面２５との間で上記内輪３を挟持して、この内輪３を上記ハブ本体２に固定できる。図示の例の場合には、上記円筒部８ａの内端面を塑性変形させる事により上記かしめ部９ａを形成する最終段階で、上記凹部１７の内面からこのかしめ部９ａの外周面に、直径方向内方に向く圧縮力が作用する。従って、このかしめ部９ａの外周縁に亀裂等の損傷が発生する事を防止できる。又、上記かしめ部９ａの基端部外周面が当接する、上記内輪３の内端開口周縁部には、断面円弧状の面取り部２０を形成している。従って、上記かしめ部９ａの基端部の曲率半径が小さくなる事はなく、この基端部にも無理な応力が加わりにくくなる。

【００１２】

【発明が解決しようとする課題】上述の様な、特開平１０－２７２９０３号公報に記載された、従来の車輪支持用ハブユニットの製造方法の場合、かしめ部９ａの外周縁に亀裂が発生する事は、十分に有効に防止できるが、このかしめ部９ａの先端面乃至内周面に亀裂が発生する可能性がある。即ち、従来構造の場合には、図１４に示した様な円筒部８ａの内周面２１の傾斜角度$\theta_{21}$を２０度程度と比較的大きくして、この円筒部８ａの基端部の肉厚と先端部の肉厚との差を大きくしていた。この様な円筒部８ａを、揺動かしめ装置に組み付けた押型１５に

より塑性変形させると、この円筒部８ａ乃至上記かしめ部９ａの先端面乃至内周面に引張の平均応力が発生し易くなる。そして、この引張の平均応力の値が大きくなると、当該部分に亀裂が発生し不良品となって廃棄しなければならなくなる事により歩留が低下するか、或は亀裂部分を補修する余分な工程が必要になり、何れにしてもコスト上昇の原因となる。

【００１３】更には、上記円筒部８ａの内周面２１の傾斜角度$\theta_{21}$が大きい為、上記押型１５によりこの円筒部８ａを押圧する事に伴って、この円筒部８ａの基部に径方向外方に向いた力が加わり易くなる。この様な力によってこの円筒部８ａの外径が広がると、この円筒部８ａの周囲に存在する段部７に外嵌した内輪３が弾性変形し、この内輪３の外周面に形成した内輪軌道１１の直径が拡大して、転がり軸受部分の予圧が変化する原因となる。本発明の車輪支持用ハブユニットの製造方法とその製造用押型は、上述の様な、車輪支持用ハブユニットの耐久性低下の原因となる、かしめ部９ａの亀裂や内輪３の直径拡大の発生を防止すべく発明したものである。

【００１４】

【課題を解決するための手段】本発明の車輪支持用ハブユニットの製造方法により造られる車輪支持用ハブユニットは、前述した従来から知られている車輪支持用ハブユニットと同様に、ハブ本体と、第一の内輪軌道と、段部と、内輪と、外輪と、複数個の転動体とを備える。このうちのハブ本体は、一端部外周面に車輪を支持する為のフランジを形成している。又、上記第一の内輪軌道は、上記ハブ本体の中間部外周面に、直接又はこのハブ本体とは別体の内輪を介して形成している。又、上記段部は、上記ハブ本体の他端部に形成されたもので、この第一の内輪軌道を形成した部分よりも外径寸法が小さくなっている。又、上記内輪は、外周面に第二の内輪軌道を形成して上記段部に外嵌されている。又、上記外輪は、内周面に上記第一の内輪軌道に対向する第一の外輪軌道及び上記第二の内輪軌道に対向する第二の外輪軌道を形成している。更に、上記各転動体は、上記第一、第二の内輪軌道と上記第一、第二の外輪軌道との間に、それぞれ複数個ずつ設けられている。そして、上記ハブ本体の他端部で少なくとも上記段部に外嵌した内輪よりも突出した部分に形成した円筒部を直径方向外方に塑性変形させる事で形成したかしめ部により、上記段部に外嵌した内輪をこの段部の段差面に向け抑え付けて、この段部に外嵌した内輪を上記ハブ本体に結合固定している。本発明の車輪支持用ハブユニットの製造方法は、上述の様な構造を有する車輪支持用ハブユニットを造る為、上記円筒部を塑性変形させて上記かしめ部とするものである。

【００１５】特に、請求項１に記載した本発明の車輪支持用ハブユニットの製造方法に於いては、押型を上記円筒部の先端面に突き当てた状態のまま、この押型からこの円筒部に、軸方向の力及び径方向外方に向いた力を付与する。そして、この円筒部を軸方向に圧縮しつつこの円筒部の先端部を径方向外方に塑性変形させて上記かしめ部とする事により、このかしめ部の加工の間中、上記円筒部の内周面部分に圧縮の平均応力（平均圧縮応力）を発生させ続ける。尚、この平均圧縮応力とは、静水応力$\sigma_m$の事を言う。又、この静水応力$\sigma_m$は３軸（ｘ、ｙ、ｚ軸）方向に作用する縦応力を$\sigma_1$、$\sigma_2$、$\sigma_3$とした場合に、$\sigma_m = (\sigma_1 + \sigma_2 + \sigma_3) / 3$で表される。又、静水圧力をｐとした場合には、$p = -\sigma_m$となる。

【００１６】又、請求項２に記載した車輪支持用ハブユニットの製造方法に於いては、円筒部を塑性変形させてかしめ部を形成するのに伴って、この円筒部を構成する金属材料の一部を径方向内方に移動させる。そして、上記かしめ部の形成完了後にこのかしめ部の内径部分に、径方向内方に膨らんだ膨出部を形成する。

【００１７】又、好ましくは、上記押型の表面で上記円筒部と当接してこの円筒部を塑性変形させる押圧面部分に、TiNの如きセラミックコーティング等の耐摩耗性を向上させる為の加工、或はショット・ピーニング等の表面粗さを低下させる加工の、一方又は双方を施す。そして、上記押圧面部分の耐摩耗性を向上させたり、この押圧面部分の摩擦係数を、０．３以上の比較的大きな値で安定させる。

【００１８】又、上記請求項２に記載した車輪支持用ハブユニットの製造方法を実施する為の押型として、請求項３に記載した様に、先端面中央部に形成された、上記円筒部の内側に押し込み自在な円すい台状の凸部と、この凸部の周囲にこの凸部の全周を囲む状態で形成された環状凹部とを備えたものを使用する。そして、好ましくは、この環状凹部の断面形状を、内径寄り部分に存在する内径側円弧部と、外径寄り部分に存在してこの内径側円弧部よりも小さな曲率半径を有する外径側円弧部とを、直接又は直線部を介して滑らかに連続させたものとする。又、上記環状凹部を上記円筒部の先端面に突き合わせる姿勢とした状態で、上記内径側円弧部の曲率半径の中心を、上記外径側円弧部の曲率半径の中心よりも、上記円筒部の直径方向に関して外側には存在させない。言い換えれば、この円筒部の直径方向に関して、上記内径側円弧部の曲率半径の中心は、上記外径側円弧部の曲率半径の中心と同じ位置に存在するか、又はこの外径側円弧部の曲率半径の中心よりも径方向内側に存在する。且つ、この外径側円弧部の曲率半径の中心は、上記円筒部の外周面よりも、この円筒部の径方向に関して外側には存在しない。即ち、外径側円弧部の曲率半径の中心は、上記の円筒部の径方向に関して、上記円筒部の外周面と同じ位置に存在するか、或は、この外周面よりも径方向内側に存在する。

【００１９】

【作用】上述の様に構成する本発明の車輪支持用ハブユニットの製造方法によれば、かしめ部の加工に伴って円筒部及びかしめ部の内周面部分に、亀裂に結び付く様な引張の平均応力が発生する事がない（請求項１の場合）か、発生しないか仮に発生しても小さな値に留まる（請求項２の場合）。又、上記かしめ部の加工に伴って、上記円筒部の基部の外径が大きくなる事がなく、段部に外嵌した内輪に円周方向の引張の平均応力が加わる事がない。この為、上記かしめ部及び第二の内輪軌道の耐久性を向上させて、優れた耐久性を有する車輪支持用ハブユニットを得られる。特に、請求項３に記載した車輪支持用ハブユニットの製造用押型を使用して上記かしめ部の加工を行なえば、良好なかしめ部を安定して形成できる。

【００２０】

【発明の実施の形態】図１～２は、本発明の実施の形態の１例を示している。尚、本発明の特徴は、ハブ本体２、２ａに内輪３を固定すべく、このハブ本体２、２ａの内端部に形成した円筒部８ｂを塑性変形させてかしめ部９ｂとする方法の改良に関する。車輪支持用ハブユニットの基本構成に関しては、図１０に示した従来構造の第１例、或は図１１に示した従来構造の第２例の場合と同様であるから、同等部分に関する図示並びに説明は省略し、以下、本発明の特徴部分を中心に説明する。尚、図１に示した２種類の構造のうち、（Ａ）は従動輪用で中心孔を持たない（充実体の）ハブ本体２を、（Ｂ）は、駆動輪用で中心にスプライン孔２６を有するハブ本体２ａを、それぞれ示している。

【００２１】上記ハブ本体２、２ａの内端部に、基端部の径方向に関する厚さ寸法がＴ、先端部の径方向に関する厚さ寸法がｔ、内輪３の軸方向内端面１８からの軸方向に関する突出量がｈ（一般的な乗用車用の車輪支持用ハブユニットの場合で５～１１㎜程度）であり、軸方向に関する長さ寸法がＨ（同じく７～１７㎜程度）である、上記円筒部８ｂを設けている。これら各寸法Ｔ、ｔ、Ｈ、ｈは、上記内輪３の各部の寸法との関係で、次の様に規制している。尚、上記突出量ｈは、この内輪３の内周面を上記円筒部８ｂに外嵌し、この内輪３の外端面を段部７の段差面２５に突き当てた状態での長さを言う。

【００２２】先ず、基端部の厚さ寸法Ｔは、上記かしめ部９ｂにより抑え付けるべき、上記内輪３の内端部の径方向に関する厚さ寸法Ｓ（一般的な乗用車用の車輪支持用ハブユニットの場合で５～９㎜程度）の６０～１００％｛Ｔ＝（０．６～１）Ｓ｝としている。上記基端部の厚さ寸法Ｔをこの様な範囲に規制する理由は、上記かしめ部９ｂの形成に伴って上記内輪３に加わる力を抑え、且つ、この内輪３を抑え付ける力を確保する為である。上記基端部の厚さ寸法Ｔが上記内輪３の内端部の厚さ寸法Ｓの６０％未満（Ｔ＜０．６Ｓ）である場合には、上記かしめ部９ｂが上記内輪３を抑え付ける力を確保する事が難しくなり、この内輪３の固定強度が不十分になる可能性がある。反対に、上記基端部の厚さ寸法Ｔが上記内輪３の内端部の厚さ寸法Ｓを越えた（Ｔ＞Ｓ）場合には、上記円筒部８ｂを塑性変形させて上記かしめ部９ｂとする際に、この円筒部８ｂが押型１５ａから受ける力のうち、径方向外方に向いた力が軸方向に加わる力に対して大きくなり過ぎる。この結果、上記円筒部８ｂ乃至かしめ部９ｂの、内周面乃至先端面に引張の平均応力が発生し、当該部分に亀裂が発生する可能性が生じる。尚、上記内輪３の外端部の厚さ寸法ｓ（一般的な乗用車用の車輪支持用ハブユニットの場合で２～８㎜程度）が上記内端部の厚さ寸法Ｓよりも大きい（ｓ＞Ｓ）場合には、上記円筒部８ｂの基端部の厚さ寸法Ｔは、上記内輪３の外端部の厚さ寸法ｓの６０～１００％｛Ｔ＝（０．６～１）ｓ｝とする。但し、この外端部の厚さ寸法ｓが４㎜未満の場合には、この厚さ寸法ｓを４㎜として計算する（ｓ＜４㎜の場合には、Ｔ＝２．４～４㎜とする）。

【００２３】次に、上記円筒部８ｂの先端部の厚さ寸法ｔは、上記基端部の厚さ寸法Ｔの７０～１００％｛ｔ＝（０．７～１．０）Ｔ｝、更に好ましくは７０～９５％｛ｔ＝（０．７～０．９５）Ｔ｝としている。この理由は、上記円筒部８ｂを上記かしめ部９ｂとするかしめ加工を面倒にする事なく、このかしめ加工の間中、上記円筒部８ｂの内周面に圧縮の平均応力（静水圧力＞０）を発生させる為である。前述の図１４に示した従来方法の如く、上記先端部の厚さ寸法ｔが上記基端部の厚さ寸法Ｔの７０％未満（ｔ＜０．７Ｔ）の場合には、円筒部８ａをかしめ部９ａ（図１５）とするかしめ加工に伴って、これら円筒部８ａやかしめ部９ａの内周面或は内端面部分に、引張の平均応力（静水圧力＜０）が発生し易くなり、当該部分に亀裂等の損傷が発生し易くなる。これに対して、上記先端部の厚さ寸法ｔが上記基端部の厚さ寸法Ｔの１００％を越えた（ｔ＞１．０Ｔ）場合には、上記円筒部８ｂの先端部の容積が徒に嵩んで、この円筒部８ｂを上記かしめ部９ｂに加工する作業が面倒になる。又、この円筒部８ｂの加工作業も面倒になる。尚、上記先端部の厚さ寸法ｔを上記基端部の厚さ寸法Ｔの９５％以下に抑えておけば、上記加工作業をより容易にできる。

【００２４】次に、前記内輪３の軸方向内端面１８からの軸方向に関する突出量ｈは、形成すべきかしめ部９ｂの大きさに応じて適切に規制する。上記円筒部８ｂが軸方向に圧縮され、径方向内方に膨出しながら上記かしめ部９ｂとなる事を考慮した場合、上記突出量ｈを、上記内輪３の内端面内周縁部に形成した、断面円弧状の面取り部２０の断面長さｈ´（一般的な乗用車用の車輪支持用ハブユニットの場合で４～１０㎜程度）とほぼ同じ（ｈ≒ｈ´）とする事が適当である。但し、この関係

（h≒h´）は、上記面取り部２０の形状や大きさが変った場合には、必ずしも成り立たない。この様に上記突出量hを規制する事により、加工後のかしめ部９ｂにより上記内輪３の内端面を確実に抑え、しかも余分な加工作業を行なう必要がなくなる。図示の様な寸法・形状の場合には、上記突出量hが上記断面長さh´よりも大幅に小さく（h≪h´）なると、上記かしめ部９ｂによる上記内輪３の抑え付け力が不十分になる。これに対して、上記突出量hが上記断面長さh´よりも大幅に大きく（h≫h´）なると、上記かしめ部９ｂの加工作業が徒に面倒になる。

【００２５】更に、前記軸方向に関する長さ寸法Hは、上記円筒部８ｂの基端部の軸方向位置Qが、上記内輪３の内周面の円筒部と面取り部２０との境界の軸方向位置Pから、同じく内輪軌道１１の外端縁の軸方向位置P´までの間に存在する様に規制する。上記基端部の軸方向位置Qが上記境界の軸方向位置Pよりも内方（図１の上方）に存在すると、上記円筒部８ｂの長さ寸法が短くなり過ぎて、上記かしめ部９ｂの品質確保が難しくなる。又、上記基端部の軸方向位置Q部分に加わる、径方向外方に向いた力が、相対的に大きくなり過ぎる可能性もある。但し、場合によっては、上記基端部の軸方向位置Qを、上記内輪３の内端面１８部分にまで移動させる事も、一応は可能である。これに対して、上記基端部の軸方向位置Qが上記内輪軌道１１の外端縁の軸方向位置P´よりも外方（図１の下方）に存在すると、上記円筒部８ｂの長さ寸法が長くなり過ぎて、ハブ本体２、２ａの剛性確保が難しくなる。又、かしめ加工に伴う上記円筒部８ｂの座屈変形により、上記内輪３の面取り部２０に上記かしめ部９ｂが密着せず、当該部分に隙間が生じる可能性も生じる。

【００２６】上述の様な寸法・形状を有する円筒部８ｂは、揺動かしめ装置に組み付けた、図２に示す様な断面形状を有する押型１５ａにより塑性変形させて、同図に示す様なかしめ部９ｂとする。この押型１５ａには、環状凹部２３が形成されており、この環状凹部２３で上記円筒部８ｂを抑え付ける事により、この円筒部８ｂを塑性変形させ、上記かしめ部９ｂとする。この様な環状凹部２３の断面形状に就いて、上記押型１５ａを中立状態（この押型の中心軸と上記円筒部８ｂ或はかしめ部９ｂの中心軸とを一致させた状態）とした場合で説明する。上記環状凹部２３の断面形状の曲率半径は、径方向に関して漸次変化しているが、変化の傾向は、段部７の外周面と内輪３の内周面１９との嵌合面の延長線αと、上記押型１５ａと上記かしめ部９ｂとが接触する範囲の径方向内端の点Uを通り上記延長線αと平行な直線βとの間（図２のA範囲）上の点を境として、互いに逆である。このA範囲内に存在する境位置（境界点）は、応力のバランスを考慮して適宜決定する。又、上記A範囲内に、平面等の、断面形状が直線となる部分を設け、この部分の径方向内外両端を境として、上記曲率半径を変化させても良い。

【００２７】先ず、上記境界点よりも外径側部分では、径方向外方に向かう程曲率半径が、比較的急激に小さくなる。この理由は、上記円筒部８ｂ及びかしめ部９ｂの先端部分に圧縮応力を発生させて、この先端部分に亀裂等の損傷が発生するのを防止する為である。これに対して、上記境界点よりも内径側部分では、径方向内方に向かう程曲率半径が、比較的緩やかに小さくなる。この理由は、かしめ作業に伴って、上記円筒部８ｂの肉が内径側に過剰に流れるのを抑え、上記境界点寄り部分に集めて、強度の大きなかしめ部９ｂを得る為である。

【００２８】前述の様な断面形状を有する上記円筒部８ｂを、上述の様な断面形状を有する環状凹部２３を有する押型１５ａにより塑性変形させると、上記円筒部８ｂを構成する金属材料の一部が径方向内方に移動して、上記かしめ部９ｂの形成完了後にこのかしめ部９ｂの内径部分に、径方向内方に膨らんだ膨出部２４が形成される。即ち、本発明の方法により得られるかしめ部９ｂの、中心軸を含む仮想平面に関する断面形状は、基端部（図２の下端部）から軸方向中間部にかけては肉厚が徐々に増大し、中間部から先端部（図２の上端部）にかけては、肉厚が徐々に減少する。そして、先端部の折れ曲がり部分では、径方向外方に向かう程、肉厚が急激に減少する。尚、上記中間部の肉厚は、当該部分での元々の上記円筒部８ｂの肉厚よりも大きくなる。

【００２９】図３の（A）（B）に、本発明の方法によりハブ本体２、２ａの内端部に形成したかしめ部９ｂの、より具体的な形状を示す。このうち、図３（A）は、従動輪用で中心孔を持たない（充実体の）ハブ本体２の内端部にかしめ部９ｂを形成した場合を、図３（B）は、駆動輪用で中心にスプライン孔２６を有するハブ本体２ａの内端部にかしめ部９ｂを形成した場合を、それぞれ示している。従動輪用で中心孔を持ったハブ本体の内端部にかしめ部を形成した場合も、図３（B）と同様である。これに対して図３（C）は、従来方法により従動輪用で中心孔を持たないハブ本体２の内端部にかしめ部９ａを形成した場合を示している。この様な図３（C）と上記図３（A）（B）とを比較すれば明らかな通り、本発明の方法により形成したかしめ部９ｂの場合には、このかしめ部９ｂの内径部分に、径方向内方に膨らんだ膨出部２４が形成される。この膨出部２４が、円筒部８ｂ（図１参照）を構成する金属材料の一部が径方向内方に移動する事により造られたものであり、その際、この金属材料に圧縮の平均応力が加わり続けたか、仮に引張の平均応力が発生しても小さな値に留まった事は明らかである。これに対し図３（C）に示した、従来方法により造られたかしめ部９ａの場合には、全体が径方向外方に塑性変形させられており、この塑性変形の際に金属材料に引張の平均応力が加わり続けた事

は明らかである。金属材料中に圧縮の応力が加わった状態では、この金属材料に亀裂の兆候が生じた場合でもこれを修復する力が加わるのに対して、引張の平均応力が加わった場合には、亀裂を増大させる方向の力が加わる。これらの事から、本発明によれば、上記かしめ部９ｂを損傷させにくく、優れた歩留を得られる事が分かる。

【００３０】更に、本発明を実施する場合に、好ましくは、上記押型１５ａの表面で上記円筒部８ｂと当接してこの円筒部８ｂを塑性変形させる押圧面部分、即ち、上記環状凹部２３の内面に、TiNの如きセラミックコーティング等の耐摩耗性を向上させる為の加工、或はショット・ピーニング等の表面粗さを低下させる加工の、一方又は双方を施す。そして、上記環状凹部２３の内面の耐摩耗性を向上させたり、この環状凹部２３の内面の摩擦係数を、０．３以上の比較的大きな値で安定させる。

【００３１】揺動かしめ装置を使用して上記円筒部８ｂを上記かしめ部９ｂに加工する際に、これら円筒部８ｂ或はかしめ部９ｂと上記環状凹部２３の内面とは強く擦れ合う。耐摩耗性を向上させれば、この様な強い擦れ合いに拘らず、上記環状凹部２３の摩耗を抑え、上記押型１５ａの耐久性向上を図れる。又、摩擦係数を大きな値で安定させれば、かしめ加工の間中、上記円筒部８ｂ或はかしめ部９ｂに圧縮の平均応力を発生させ続ける事ができ、得られたかしめ部９ｂに、亀裂等の損傷が発生しにくくできる。

【００３２】即ち、上記円筒部８ｂを塑性変形させて上記かしめ部９ｂとする際に、これら円筒部８ｂ或はかしめ部９ｂの中間部乃至は先端寄り部分に引張の平均応力が加わると、当該部分に亀裂等の損傷が発生し易くなるが、それぞれが前述の様な形状を有する円筒部８ｂを押型１５ａにより塑性変形させる事により、上記部分に圧縮の平均応力を作用させて、上記亀裂等の損傷の発生を抑える事ができる。そして、上記環状凹部２３の内面の摩擦係数を大きくする事により、上記部分に圧縮の平均応力を、より確実に作用させる事ができて、上記亀裂等の損傷の発生防止効果を、より確実にできる。

【００３３】尚、鋼製の押型１５ａに形成した上記環状凹部２３に特に表面処理を施さない場合には、この環状凹部２３の摩擦係数は０．０５～０．２程度であるが、前記TiNの如きセラミックコーティングを施した場合の摩擦係数は、０．３～０．５程度と、大きく、しかも安定する。この様なセラミックコーティングを施した押型１５ａを使用して、加工部に潤滑剤を介在させる事なく、上記円筒部８ｂを塑性変形させて上記かしめ部９ｂを形成すれば、亀裂等の損傷を発生する事なく、良質のかしめ部９ｂを、高い歩留で造れる。尚、上記セラミックコーティングを施す前又は施した後に、上記環状凹部２３の表面部分にショット・ピーニングを施すと、この環状凹部２３部分の摩擦係数がより高くなり、より良好なかしめ部９ｂを得られる。尚、セラミックコーティングを施さずに、ショット・ピーニングのみを施した場合でも、上記環状凹部２３に全く表面処理を施さない場合に比べて、耐摩耗性の向上と摩擦係数の増大とを図れる。

【００３４】次に、本発明を実施する場合に、揺動かしめ装置に組み込んだ状態で使用する押型１５ａの好ましい形状に就いて説明する。即ち、ハブ２、２ａの内端部に形成した円筒部８ｂの先端部を径方向外方に塑性変形させてかしめ部９ｂとする加工作業の間中、上記円筒部８ｂの内周面部分に圧縮の平均応力を発生させ続けるか、仮に引張の平均応力が発生しても小さな値に留める為には、この円筒部８ｂの形状を工夫する他、この円筒部８ｂの先端面に突き当てる押型１５ａの形状も工夫する必要がある。この押型１５ａとしては、次述する図４に示す様に、上記円筒部８ｂの内側に押し込み自在な円すい台状の凸部１６を先端面中央部に、この凸部１６の周囲に環状凹部２３をこの凸部１６の全周を囲む状態でこの凸部１６と同心に、それぞれ形成したものを使用する。この様な押型１５ａの場合、特に上記環状凹部２３の断面形状が重要になる。この断面形状を、前述の特開平１０－２７２９０３号公報に記載された構造の如く、多種類の円弧を連続させて成る複合曲面とする事も考えられるが、この様な複合曲面の加工は面倒で、上記押型１５ａの製造コストが嵩む原因となる。そこで、以下の例では、上記環状凹部２３のうちで上記円筒部８ｂの加工に供される部分の断面形状を、互いに異なる曲率半径を有する２種類の円弧のみで、或は２種類の円弧と直線部とで構成する場合に就いて説明する。

【００３５】先ず、本発明の実施に好適である上記環状凹部２３の基本的な断面形状としては、図４に示す様に、内径側円弧部２７の外周縁と外径側円弧部２８の内周縁とを滑らかに連続させた形状が考えられる。これら両円弧部２７、２８のうち、内径寄り部分に存在する内径側円弧部２７の曲率半径$R_{27}$（一般的な乗用車用の車輪支持用ハブユニットの場合で３～１３㎜程度）は、外径寄り部分に存在する外径側円弧部２８の曲率半径$R_{28}$（同じく３～７㎜程度）よりも大きくしている。本例の場合、これら両曲率半径$R_{27}$、$R_{28}$の中心は、上記図４に示す様に、上記環状凹部２３を上記円筒部８ｂの先端面に突き合わせる姿勢とした状態で、この円筒部８ｂの中心軸に対し平行な、単一の仮想直線上に位置する。

【００３６】即ち、揺動かしめ装置に組み付けた状態で上記円筒部８ｂの先端部に押し付けられる上記押型１５ａの中心軸イは、この円筒部８ｂの中心軸ロに対し、僅かな（例えば２度以下の）角度θだけ傾斜している。従って、上記環状凹部２３は上記円筒部８ｂの先端部に、図５に示す様に、円周方向の一部のみが押し付けられた状態となる。押し付けられる部分は、上記押型１５ａの揺動変位に伴って円周方向に変化し、その結果上記円筒

部８ｂが、周方向に関して連続的に、少しずつ塑性変形させられる。この為、上記環状凹部２３に関しては、実際に上記円筒部８ｂの先端部に押し付けられる部分（図４～５の右側部分）の断面形状が重要になる。そこで、上記環状凹部２３の断面形状に関しては、図４～５に示す様に、この環状凹部２３を上記円筒部８ｂの先端面に突き合わせる姿勢とした状態で論ずる。従って、この断面形状に関する記述は、押型１５ａとハブ本体２、２ａとを近づけた場合にそのまま上記円筒面８ｂの先端面に突き当てられる図４～５の右側部分で成り立つものであり、突き当てられる事のない、図４～５の左側部分では成り立たない。

【００３７】図４に示した構造の場合には、上述した様に、内径寄り部分に存在する内径側円弧部２７の曲率半径$R_{27}$の中心と、外径寄り部分に存在する外径側円弧部２８の曲率半径$R_{28}$の中心とを、上記円筒部８ｂの中心軸ロに対し平行な、単一の仮想直線上に位置させると共に、この仮想直線の軸方向に関する上記両中心のずれ量$\gamma$を、上記両曲率半径の差（$R_{27}-R_{28}=\gamma$）に一致させている。従って、上記内径側円弧部２７の外周縁と上記外径側円弧部２８の外周縁とは、互いに接線方向に延長される事により、滑らかに連続している。又、上記両曲率半径$R_{27}$、$R_{28}$が位置する上記仮想直線は、やはり上記環状凹部２３を上記円筒部８ｂの先端面に突き合わせる姿勢とした状態で、この円筒部８ｂの外周面よりも、この円筒部８ｂ及び上記押型１５ａの径方向に関して外側には存在しない。

【００３８】即ち、上記仮想直線は、上記円筒部８ｂの外周面の母線を延長した鎖線ハと一致するか、又はこの鎖線ハよりも内径側（上記円筒部８ｂの中心軸ロ寄り）に存在する。但し、内径寄りに設ける場合でも、上記仮想直線と上記鎖線ハとの距離（変位量）は、１．０㎜（更に好ましくは０．５㎜）程度に止める。この様に上記両曲率半径$R_{27}$、$R_{28}$の位置を規制する事により、得られたかしめ部９ｂによる内輪３ｂの抑え力を確保し、しかも上記押型１５ａの損傷防止を図れる。この点に関して本発明者が行なった実験の結果に就いて、図６～７により説明する。

【００３９】先ず、図６は、上記変位量と、得られたかしめ部９ｂによる内輪３ｂの抑え力の大小との関係に就いて示している。この図６の縦軸は、上記かしめ部９ｂを形成する際に、上記押型１５ａにより内輪３ｂを軸方向外方に押圧した力（上記かしめ部９ｂの加工の最終段階で、このかしめ部９ｂを介して上記内輪３ｂに加えた軸方向の力）$F_1$に対する、この押型１５ａの押圧力を除いた後、上記かしめ部９ｂが上記内輪３ｂを軸方向外方に押圧している力$F_2$の割合（$F_2/F_1$）を表している。この割合が大きい程、上記押型１５ａの加える力を小さく抑えて上記内輪３ｂの抑え力の大きなかしめ部９ｂを形成できる事に繋がり、かしめ加工時にこの内輪３ｂに加わる負担を低減できる為、好ましい。又、図６の横軸に記載した数値は、上記変位量を表している。尚、この変位量が「＋」とは、上記仮想直線が上記円筒部８ｂの外周面の母線を延長した鎖線ハよりも外径側に位置する事を、「－」とは、同じく内径側に位置する事を、変位量＝０とは、上記仮想直線が上記鎖線ハ上に位置する事を、それぞれ表している。本発明者が行なった実験によると、上記変位量が－１～＋１．１㎜の範囲で、上記かしめ部９ｂに要求される仕様を満足した。但し、＋０．６４㎜の場合と＋１．１㎜の場合とは、上記割合が他の場合よりも小さかった。又、－１㎜の場合には、得られたかしめ部９ｂの一部に欠肉が生じた。これに対して、０㎜と－０．５㎜の場合とは、上記割合が大きく、得られたかしめ部９ｂの外観も良好であった。

【００４０】次に、図７は、上記変位量と、かしめ加工時に上記押型１５ａに加わる力の大きさとの関係を示している。この図７の横軸の意味は、上記図６と同じである。又、この図７の縦軸に表した、かしめ加工時に上記押型１５ａに加わる力の大きさが小さい程、この押型１５ａに亀裂等の損傷が発生しにくくして、この押型１５ａの耐久性を確保し、生産コストを低く抑えられる事に繋がる。即ち、上記力が大きくなると、上記押型１５ａの外周寄り部分で前記環状凹部２３を囲む部分に大きな力が加わり、この部分に、この環状凹部２３の底面側から亀裂が生じ易くなる。この様な亀裂が生じた場合には上記押型１５ａの交換が必要になり、その分製造コストが嵩む為、上記力は小さい程好ましい。本発明者が行なった実験によると、上記変位量が０㎜の場合に上記力が最も小さく、－０．５㎜の場合がそれに続いた。この変位量が＋０．６４㎜と＋１．１㎜の場合とは、上記力が大きくなり、押型１５ａの耐久性確保が難しい事が確認された。尚、上記変位量が－１㎜の場合は、上述の様に得られたかしめ部９ｂに欠肉が生じた為、図７には記載しなかった。この様な図７の結果からも、前記変位量が０㎜の場合と－０．５㎜の場合（勿論その中間の値の場合も同様）とが好ましい事が分かる。

【００４１】次に、図８により、押型１５ａの環状凹部２３の断面形状に関して、内径側円弧部２７の外周縁と外径側円弧部２８の内周縁とを直線部２９を介して連続させた場合に就いて説明する。この様な直線部２９を設ける場合には、上記内径側円弧部２７の曲率半径$R_{27}$の中心を、上記外径側円弧部２８の曲率中心$R_{28}$の中心よりも、ハブ本体２、２ａの径方向に関して内径側に少しずらせる事により、成形時にかしめ部９ｂに加わる最大静水圧力を抑える事ができる。この点に関して本発明者が行なった実験の結果に就いて、図９により説明する。尚、この実験では、上記外径側円弧部２８の曲率中心$R_{28}$の中心を、上記ハブ本体２ａの円筒部８ｂの外周面の母線（＝内輪３の内周面の母線）の延長線（鎖線ハ）上に位置させ、この延長線と上記内径側円弧部２７の曲率

半径$R_{27}$の中心との、上記円筒部８ｂの径方向に関する距離δ（変位量）を変えて、この変位量δの違いが上記最大静水圧力に及ぼす影響を求めた。

【００４２】この様な条件で行なった実験の結果を示す図９で、横軸に表した変位量が０㎜の場合とは、前述の図４～７で変位量が０㎜の場合と同じである。又、－０．５㎜、－１㎜とは、上記内径側円弧部２７の曲率半径$R_{27}$の中心が、上記ハブ本体２ａの円筒部８ｂの外周面の母線の延長線（鎖線ハ）よりも内側にそれぞれ０．５㎜或は１㎜ずれた部分に存在する場合｛図８（Ａ）｝を示している。尚、図８（Ｂ）は、上記変位量が「＋」、即ち上記母線の延長線（鎖線ハ）よりも外側に上記曲率半径$R_{27}$の中心が存在する、好ましくない形状を示している。

【００４３】この様な条件で行なった実験から明らかな通り、上記内径側円弧部２７の曲率半径$R_{27}$の中心を上記外径側円弧部２８の曲率中心$R_{28}$の中心よりも内側に位置させれば、成形時にかしめ部９ｂに加わる最大静水圧力を抑える事ができる。従って、上記ハブ本体２、２ａを構成する金属材料の延性が低い場合には、上記直線部２９を設定して、成形時にかしめ部９ｂに加わる最大静水圧力を抑える事が考えられる。但し、上記直線部２９の長さ、即ち上記変位量δが１㎜を越えると、得られるかしめ部９ｂの一部に欠肉が生じる場合がある為、この変位量δは１㎜以下に抑える事が好ましい。

【００４４】

【発明の効果】本発明の車輪支持用ハブユニットの製造方法とその製造用押型は、以上に述べた通り構成され作用するので、ハブ本体に対する内輪の固定を確実に行なえ、しかもこの内輪の外周面に形成した内輪軌道の転がり疲れ寿命を十分に確保できる車輪支持用ハブユニットの実現を図れる。

【図面の簡単な説明】

【図１】本発明の車輪支持用ハブユニットの製造方法の実施の形態の１例を、かしめ部を形成する以前の状態で示す部分断面図。

【図２】同かしめ部を形成した後の状態で示す部分断面図。

【図３】本発明の方法により得られるかしめ部と従来方法により得られるかしめ部との断面形状を示す図。

【図４】本発明の車輪支持用ハブユニットの製造用押型の実施の形態の１例を示す、ハブ本体と対向させたまま未だ当接させていない状態で示す断面図。

【図５】同じくかしめ部の加工をほぼ完了した状態で示す断面図。

【図６】押型の凹部の断面形状の相違が、得られたかしめ部の内輪を抑え付ける力の大きさに及ぼす影響を知る為に行なった実験の結果を示すグラフ。

【図７】同じく押型に加わる力の大きさに及ぼす影響を知る為に行なった実験の結果を示すグラフ。

【図８】押型の凹部の断面形状の別例を示す部分拡大断面図。

【図９】押型の凹部の断面形状の相違が、かしめ部の加工時に加わる静水応力の最大値に及ぼす影響を知る為に行なった実験の結果を示すグラフ。

【図１０】従来構造の第１例を示す断面図。

【図１１】同第２例を示す断面図。

【図１２】従来方法でかしめ部を形成する状態を示す部分断面図。

【図１３】同じくかしめ部の断面形状を説明する為の部分断面図。

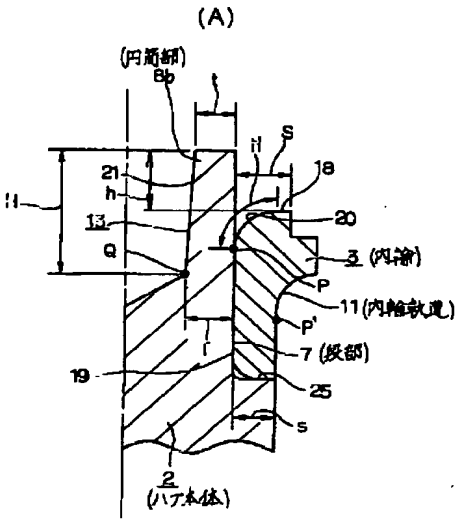
【図１４】同じくかしめ部を形成する以前の状態で示す部分断面図。

【図１５】同じくかしめ部を形成する状態を示す部分断面図。

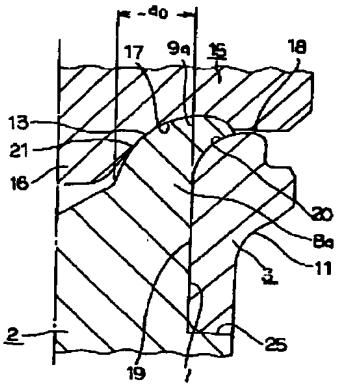
【符号の説明】

１　車輪支持用ハブユニット
２、２ａ　ハブ本体
３、３ａ、３ｂ　内輪
４　外輪
５　転動体
６　フランジ
７　段部
８、８ａ、８ｂ　円筒部
９、９ａ、９ｂ　かしめ部
１０　外輪軌道
１１　内輪軌道
１２　取付部
１３　テーパ孔
１４　抑え片
１５、１５ａ　押型
１６　凸部
１７　凹部
１８　内端面
１９　内周面
２０　面取り部
２１　内周面
２３　環状凹部
２４　膨出部
２５　段差面
２６　スプライン孔
２７　内径側円弧部
２８　外径側円弧部
２９　直線部

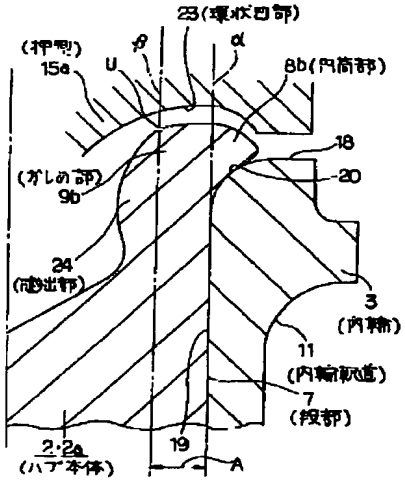
【図1】



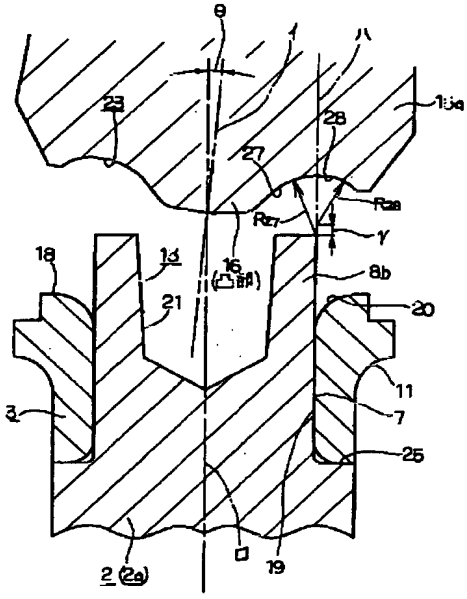

【図12】



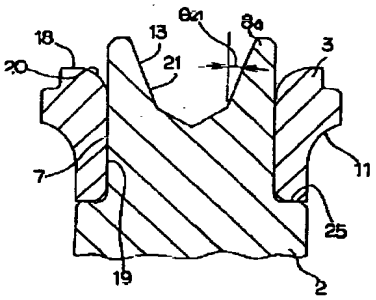

【図2】



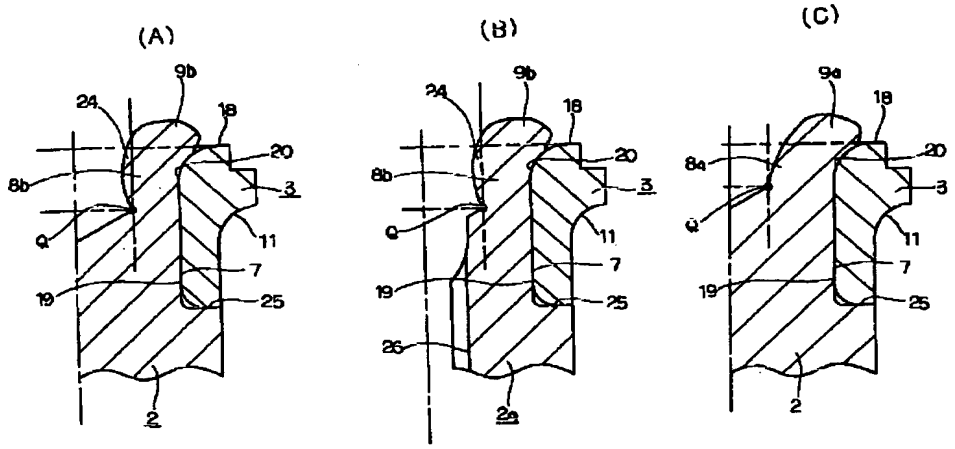

【図4】



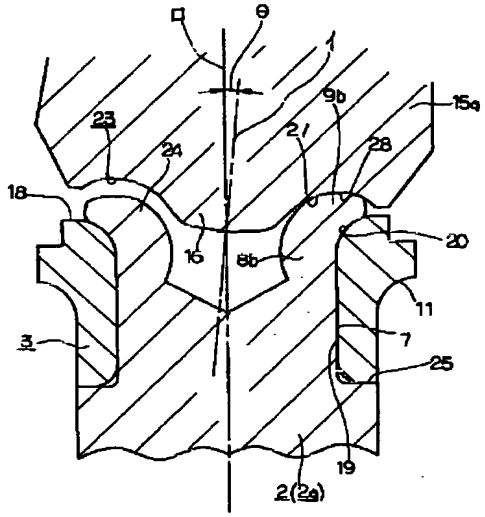

【図14】



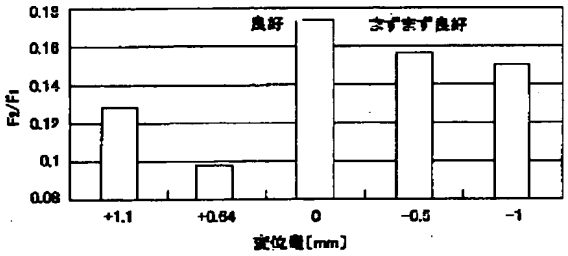
【図3】


(A)
(B)
(C)
9b
24
18
20
8b
3
Q
11
7
19
25
2
26
2a
9a
8a

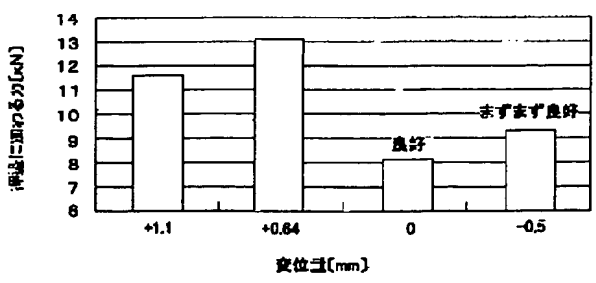
【図5】


θ
1
9b
15a
23
24
21
28
18
20
16
8b
11
3
7
25
19
2(2a)

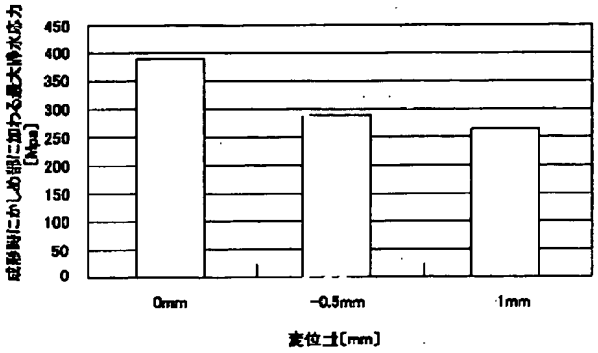
【図6】


良好
まずまず良好
Fs/Fi
0.18
0.16
0.14
0.12
0.1
0.08
+1.1
+0.64
0
-0.5
-1
変位量[mm]

【図7】

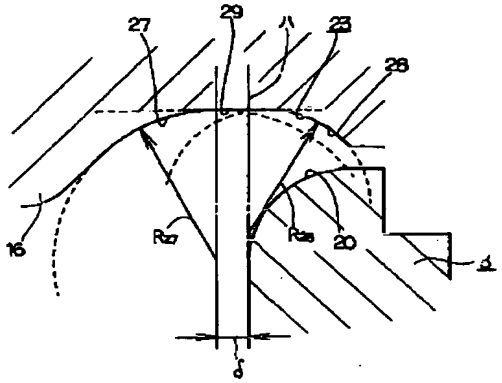

14
13
12
11
10
9
8
7
6
まずまず良好
良好
+1.1
+0.64
0
-0.5
変位量[mm]

【図9】

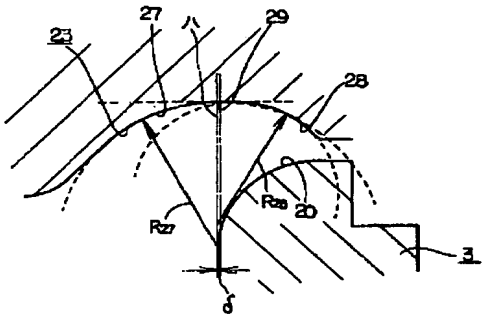

450
400
350
300
250
200
150
100
50
0
0mm
-0.5mm
-1mm
変位量[mm]

【図8】

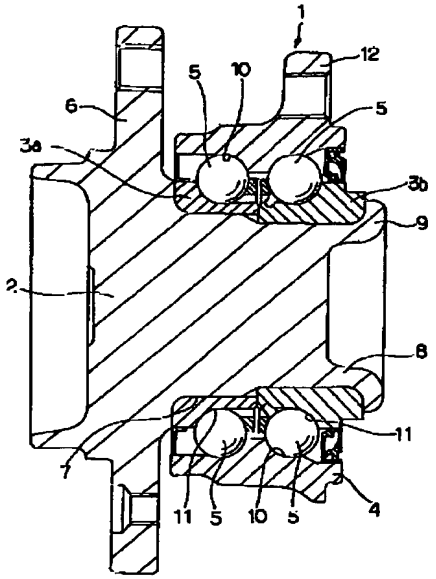
(A)



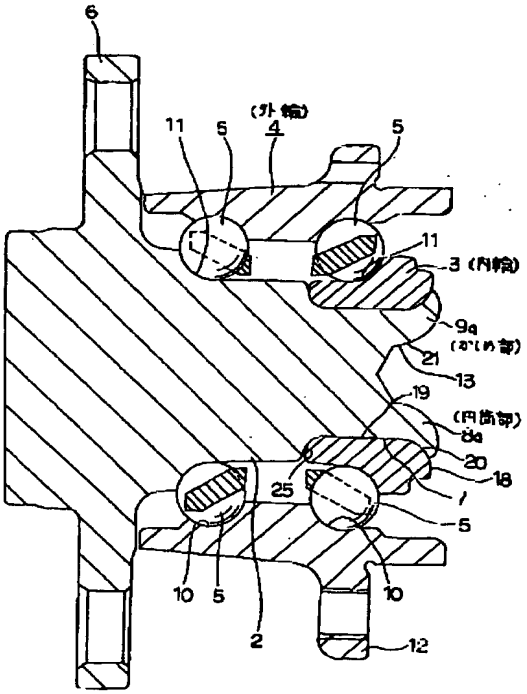

(B)



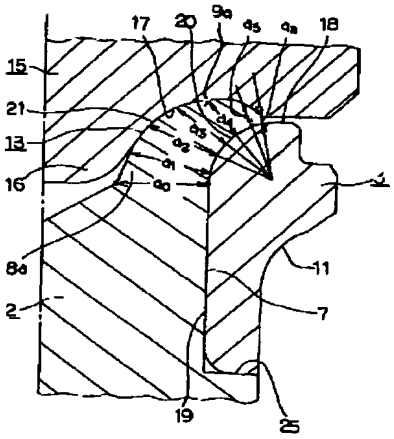

【図10】




【図11】




【図13】



【図15】